SCIENCE ABSTRACTS

SECTION A

PHYSICS.

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A star (*) indicates that the Abstract deals with Apparatus and Instruments.

MARCH, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

579. Quadrupole moment of the deuteron and nuclear forces. S. FLÜGGE. *Zeits. f. Physik*, **113**, 9–10, *pp.* 587–595, 1939.—The existing formula for the forces between elementary particles in the nucleus is extended by terms for spin-orbit coupling, and the determination of the constants in it is attempted on the basis of the saturation of the heavy nuclei (Volz and Kemmer), the binding energy in the deuteron ground state and in the excited state of the 2-body problem, and the quadrupole moment of the deuteron. C. B. A.

580. Distance of energy-levels of atomic nuclei. P. O. MÜLLER. *Phys. Zeits.*, **40**, *pp.* 615–617, *Oct.* 1, 1939.—The proper-frequencies of surface- and volume-waves in a vibrating liquid drop are calculated, and, by means of Bethe's theory, used to determine the distance of energy-levels for light nuclei. The agreement with experimental data, however, is best if the surface vibrations alone are considered. L. E. F.

***581. Thermal diffusion tube for separation of isotopes.** K. CLUSIUS AND G. DICKEL. *Zeits. f. phys. Chem. Abt. B*, **44**, 5–6, *pp.* 397–473, 1939. —The separation of isotopes by thermal diffusion according to the work of Enskog and Chapman is discussed. It is shown that by arranging the diffusion vessel in an inclined position a greatly increased separation of heavy and light components can be obtained, owing to the formation of convection currents. An apparatus for the practical application of this principle is described. The "cold wall" is the outer wall of a glass tube and the "hot wall" is a heated wire stretched axially along the length of the tube. A trial experiment with CO_2 and H_2 gave in about 2 hrs. almost complete separation. An experiment with Ne gave the following concentrations of isotopes: $^{20}Ne : {}^{21}Ne : {}^{22}Ne = 68{\cdot}4 : 0{\cdot}6 : 31{\cdot}0$ as compared with $90{\cdot}0 : 0{\cdot}3 : 9{\cdot}7$ for normal Ne. The optimum working conditions for such a tube—length and diameter of the tube, temperature of the wire, etc.—are considered, as well as the variation of gas concentration along the tube. The use of a number of such tubes in series is also described. The second part of the paper deals with the separation of the isotopes of Cl_2. The Cl_2 was used in the form of $H^{35}Cl$ and $H^{37}Cl$ prepared from purest KCl. Five separator tubes, each 36 m. long, were used and the final gas samples obtained consisted of 99·6% ^{35}Cl and 99·4% ^{37}Cl. The energy expended in the separation amounts to $3{\cdot}7 \times 10^{10}$ cal. per mol. of HCl. [See following Abstract.] G. G.

582. Theory of thermal diffusion method of separation. P. DEBYE. *Ann. d. Physik*, **36**, 3–4, *pp.* 284–294, *Oct.*, 1939.—A theory is given of the method used by Clusius and Dickel [see preceding Abstract] for the separation of liquid or gaseous mixtures by means of thermal diffusion. [See following Abstract.] R. W. P.

583. Kinetics of thermal diffusion in fluids. K. WIRTZ. *Ann. d. Physik*, **36**, 3–4, *pp.* 295–302, *Oct.*, 1939.—The assumption that the mean distance of migration of a particle in the lattice is independent of tem-

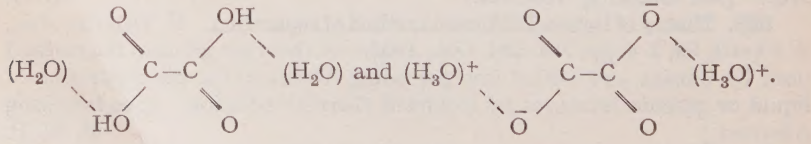
perature, T, is shown to lead to the result for condensed phases that $D' = \delta D/\delta T$ where D′ is the thermal diffusion coefficient and D is the normal diffusion coefficient. By using a special oscillatory model it is then possible to derive a simple expression for the ratio D′/D which enters into all calculations relating to the separation of isotopes by thermal diffusion. [See preceding Abstract.] R. W. P.

584. Concentration of C^{13} by thermal diffusion. A. O. Nier. *Phys. Rev.*, **57**, *pp.* 30–34, *Jan.* 1, 1940.—A thermal diffusion column employing methane gas has been constructed for the purpose of concentrating C^{13}. A determination of the separation factor of the column for various pressures indicated a quantitative agreement between experiment and the theory of Furry, Jones and Onsager [see Abstract 2666 (1939)]. When a reservoir was attached to the top of the column it was possible to produce methane containing over 4 times the normal amount of $C^{13}H_4$. [See following Abstract.] Author.

585. Concentration of isotopes by thermal diffusion. Rate of approach to equilibrium. J. Bardeen. *Phys. Rev.*, **57**, *pp.* 35–41, *Jan.* 1, 1940.—The time-dependent partial differential equation involved in the theory of the operation of a Clusius thermal diffusion column is discussed. Solutions presented give the concentration of a given isotope at any point in the column as a function of time. Some are compared with experimental results of Nier [see preceding Abstract] and good agreement is obtained. Author.

586. Improvements in Fourier analysis of electronic structures. P. Debye. *Phys. Zeits.*, **40**, *pp.* 573–577, *Sept.* 15, 1939.—The radial distribution method of Fourier analysis proposed by Pauling and Brockway has already been criticized by the author [see Abstract 15 (1939)], who showed that while it was theoretically suitable for the determination of atomic distances, yet in practice certain difficulties arose. Rouault [see Abstract 2627 (1939)], however, has recently stated that the method of Pauling and Brockway gives non-convergent series, but the present investigation demonstrates that no convergence difficulties arise in the Pauling-Brockway treatment and that Rouault's new process is not sufficiently accurate for the determination of atomic distances. H. H. Ho.

587. Study of chemical linkages by Fourier analysis. Part III. Linking in quartz. Part IV. Oxygen link in oxalic acid dihydrate. R. Brill, C. Hermann and C. Peters. *Naturwiss.*, **27**, *pp.* 676–678, *Oct.* 6, 1939.—The electron density in α-quartz, projected on a plane containing the Si-O linking has been obtained. The Si-O link is intermediate between a homopolar and a heteropolar link. A Fourier analysis of the electron density in crystals of hydrated oxalic acid has been carried out. The results are compared with those of other workers, and in general the interatomic distances are found to be greater. There appears to be resonance between the two structures:



The projection diagram clearly shows the presence of hydroxonium, H_3O^+, ions. [See Abstract 1861 (1939).] A. J. M.

588. X-ray study of polymetatelluric esters. M. MATHIEU AND C. STORA. *Comptes Rendus*, **209**, *pp.* 834–836, *Dec.* 4, 1939.—X-ray examination by Guinier's method [see Abstract 2692 (1937)] of the Me, Et, Pr, Bu and Am and the iso-Pr, iso-Bu and iso-Am esters of polymetatelluric acid confirms their amorphous structure. The lengthening of the hydrocarbon chain is accompanied by a progressive tightening of the concentric rings. C. A. S.

589. Internuclear distances in Se_2, Te_2, and HgCl by electron diffraction. L. R. MAXWELL AND V. M. MOSLEY. *Phys. Rev.*, **57**, *pp.* 21–23, *Jan.* 1, 1940.—Electron diffraction photographs have been obtained from the gas molecules Se_2, Te_2, and HgCl. The internuclear distances found for Se_2 and Te_2 were $2{\cdot}19 \pm 0{\cdot}03$ Å and $2{\cdot}59 \pm 0{\cdot}02$ Å, respectively, while for HgCl a separation of $2{\cdot}23 \pm 0{\cdot}03$ Å was obtained. Additional photographs were taken of $HgCl_2$ indicating an Hg-Cl distance of $2{\cdot}27 \pm 0{\cdot}03$ Å near to the above value for HgCl. Comparison is made with band spectrum data on the internuclear distances for Se_2 and Te_2. AUTHORS.

590. Calculation of force constants in some methyl compounds. J. W. LINNETT. *J. Chem. Phys.*, **8**, *pp.* 91–98, *Jan.*, 1940.—In this paper are described force constant calculations on ethane, the methyl halides, methyl cyanide and isocyanide. The potential function used is based on a valency-type force field with the introduction of one cross term rendered likely by physical considerations. The applicability of this function to the molecules under consideration is tested with the ethane molecule. The C-C bond force constant in methyl cyanide is found to be considerably greater than in ethane, indicating that the bond has some double-bond character in the cyanide, as has been suggested by Pauling, Springall and Palmer [see Abstract 2274 (1939)]. It is found that the bending constant of the HCH angle remains very constant in the four methyl halides, there being changes, however, on passing to the other compounds. Other variations in the force constants of corresponding links, similar to these, are studied and their significance discussed. AUTHOR.

591. Simple relationship between ionic refraction, ionic radius and atomic number of element. Part II. E. KORDES. *Zeits. f. phys. Chem. Abt. B.*, **44**, 5–6, *pp.* 327–341, 1939.—The empirical formula $\{\sqrt[3]{(R/0{\cdot}603)}\}^{2/3} = k \cdot r_z \cdot z^{2/(n-1)}$, relating ionic radius, r, with refraction, R, (z = valence of ion, n = Born repulsion index, $k = 1{\cdot}00$ or $1{\cdot}19$ according as the ionic configuration is like or unlike that of a rare gas), as proposed in Part I [see Abstract 297 (1940)], makes possible the calculation of interatomic distances in molecules whose molecular refractions are known. The formula can be applied to both crystalline and amorphous compounds. Many data are tabulated and show maximum deviations of only a few per cent in the atomic radii. A method is indicated for deducing the ionic refractions as well as the radii of the individual ions when the molecular refraction and the internuclear distances in the molecule are known. C. B. A.

592. Chemical force as an effect of a material field. F. HUND. *Ann. d. Physik*, **36**, 3–4, *pp.* 319–327, *Oct.*, 1939.—The author first discusses the nature of chemical force or affinity. He then investigates mathematically the viewpoint of chemical force being an effect of the statical material field. The subject matter is treated under the following headings: Scalar material field first without and then with electromagnetism; nature of the material field around an atom; expression of the various forces

present; exchange forces and the chemical force between two atoms. Diagrams for the lines of force are included in the last section. H. H. Ho.

593. Molecular binding energy between H and Al atoms in aluminium. H. Schüler, H. Gollnow and E. Fechner. *Ann. d. Physik*, **36**, 3–4, *pp.* 328–334, *Oct.*, 1939.—From the spectroscopic data of aluminium hydride in the hollow kathode it has been established that: (1) AlH-molecules occur in the metallic aluminium. (2) The unusually intensive Al-H bands in various light sources are to be ascribed to the Al-H molecules sublimed from the electrodes rather than to formation of the AlH in the gas chamber. (3) The molecular binding energy between atomic H and the Al atoms in the aluminium amounts to $0{\cdot}228 \pm 0{\cdot}004$ eV, and was determined from the Al-H bands of the $^1\Pi - {}^1\Sigma$-transition at the lowest discharge pressure. (4) The difference between excitation and absorption luminosities in collision processes is demonstrated. H. H. Ho.

See also Abstracts 605, 728, 781, 812, 832.

COLLOIDS.

594. Constitutional and hydrated H_2O in textile fibres. A. Baroni. *Gazz. Chim. Ital.*, **69**, *pp.* 435–443, *July*, 1939.—Plots of H_2O content against heat of hydration and atmospheric vapour pressure are reported for silk, synthetic silk and wool products, cotton and wool. While the vegetable fibres show continuous curves, those for silk and wool show kinks at $1\frac{1}{2}$ and 2% H_2O respectively. Tensile measurements during drying confirm the phenomenon, which the author holds to be due to the existence of two kinds of water in the fibre and the possibility of their interchange. D. R. H.

***595. Centrifugal dust extraction. Ideal vortex-sink and its approximate realization.** E. Feifel. *Forsch. IngWes.*, **10**, *pp.* 212–219, *Sept.–Oct.*, 1939.—To extract fine, light dusts from gases, a high value of the centrifugal force is necessary. At the same time, the secondary flows, depending on friction, and upon the shapes of the chambers and passages, exercise considerable effect, but depend, of course, very much upon the detail of construction. W. G. B.

596. Photoelectric sedimentation method of measuring particle-size distribution and efficiency of dust-removal apparatus. K. Gösele. *Forsch. IngWes.*, **10**, *pp.* 235–245, *Sept.–Oct.*, 1939.—A method is described for determining the size distribution of the particles in a dusty atmosphere based on the measurement of the rate of fall of the dust particles in an enclosed space. A light beam is passed through the sedimentation tube and the intensities of the transmitted light and of the Tyndall light scattered at right angles are measured by vacuum photocells with amplifiers. The scattered light intensity is proportional to the surface area of the particles for sizes greater than about 1μ. The method can be used for measurements of size distribution between 1 and 30μ and for particle densities above 10 mg./m^3. The application of the apparatus for measuring the efficiency of dust removal devices is described. J. B. W.

597. Colloidal behaviour of clays as related to their crystal structure. T. F. Ford, A. G. Loomis and J. F. Fidiam. *J. Phys. Chem.*, **44**, *pp.* 1–11, *Jan.*, 1940.—Certain chemicals, such as sodium tannate and various phosphates, which in low concentration reduce the apparent viscosity of concentrated clay suspensions, appear to be adsorbed on specific parts of the crystal faces of the clay particles, and to destroy the aggregation of the

particles, into structures. The gelling and coagulating effects of most salts are attributed to changes in concentration of the inter-particle ionic atmospheres. On the basis of the detailed crystal structures of clays, chemical formulae are written for colloidal clay particles and are used in explaining the various phenomena encountered with clay suspensions.

AUTHORS.

598. Quantitative determination of coagulation. H. A. WANNOW. *Kolloid-Beihefte*, **50**, 10–12, *pp.* 367–474, 1939.—The various methods, direct and indirect, of determining coagulation are reviewed, and a method of investigating coagulation, based on the transmission of light through the sol, is developed. The determination is carried out with the aid of a photo-cell sensitive to infra-red. The effect of addition of electrolytes to sols was investigated by the method. The transmission of light varies with the molarity or activity coefficient of the coagulating ion according to an S-shaped curve. The variation of the coagulation value of As_2S_3 and TiO_2 sols with the concentration of sol was determined over a large range of concentrations. In the case of As_2S_3 Burton's rule is obeyed, but this is not so with the positively charged TiO_2 sol. The coagulation of MnO_2, gum mastic, humic acid, and $Fe(OH)_3$ by a series of electrolytes was also investigated. In the case of As_2S_3 sols the effect of the following binary mixtures of electrolytes was examined: $KCl + MgCl_2$, $KCl + BaCl_2$, $KCl + LaCl_3$, and $MgCl_2 + LaCl_3$. With the first two the effect is greater than the simple additive effect, whereas with the second two it is less than this. The dissolution of As_2S_3 sols can also be followed by the method. Addition of NaOH first causes the sol to become molecularly dispersed, whereas Na_2CO_3 first brings about coagulation and then dissolution. The method is also satisfactory for the examination of the coagulation of milk and solutions of proteins. A. J. M.

599. Effect of "T" and "R" activated water on colloidal gold. G. PICCARDI AND E. BOTTI. *Gazz. Chim. Ital.*, **69**, *pp.* 609–614, *Sept.*, 1939.—The effect of using activated water in preparing a gold colloid is marked—the turbidity being diminished, and the colour being deeper blue and more intense, the latter effect is particularly marked with *R* water. In contrast to the results with non-metallic colloids both modifications appear to act in the same sense. [See also Abstract 2998 (1939).] D. R. H.

600. Mutual electrical energy of two colloidal particles: General theory, using approximate Debye-Hückel equation. S. LEVINE AND G. P. DUBE. *Phil. Mag.*, **29**, *pp.* 105–128, *Feb.*, 1940.—Making use of the approximate Debye-Hückel equation in the theory of electrolytes a general method of determining the mutual electrical energy of two identical spherical colloidal particles has been developed. The final result for the energy is expressed as a series of which the first three terms, forming a first, second, and third approximation, are considered in detail. Both metallic and insulating particles are treated. [See Abstract 1864 (1939).] AUTHORS.

601. Property of radiocolloids. C. CHAMIÉ AND B. E. MARQUES. *Comptes Rendus*, **209**, *pp.* 877–879, *Dec.* 11, 1939.—Solutions of Po in HNO_3 of varying concentration were poured on slabs of paraffin and the surface after pouring away the solution examined photographically. The percentage of Po deposited as colloidal aggregates from a strongly acid solution is a function of the amount of Po contained therein, the percentage decreasing as the amount of Po increases. [See Abstract 2284 (1939.] C. A. S.

***602. Direct air-driven transparent ultracentrifuges.** J. W. McBain and A. H. Lewis. *J. Phys. Chem.*, **43**, *pp.* 1197–1205, *Dec.*, 1939.—The present definitive development of the direct air-driven transparent ultracentrifuge is described. It gives results equal in accuracy to those of any other transparent ultracentrifuge down to proteins as small as egg albumin. It is emphasized that, in accordance with the classical mathematical analysis of Mason and Weaver [see Abstract 1676 (1924)] all monodisperse substances give an identical distribution in any ultracentrifuge provided that the resolving power, $1/a$, is kept constant. Since this is proportional to the field of force, the particle weight, and the radial length of cell, there is no theoretical difference whatsoever between cells of different dimensions so long as this product is maintained constant. Authors.

See also Abstracts 789, 821, 824.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

603. Crystallographic studies of meteoric iron. J. Young. *Roy. Soc., Phil. Trans. A.*, **238**, 794, *pp.* 393–421, *Nov.* 24, 1939.—A detailed investigation of the mutual orientations of the chief constituents, kamacite and taenite, of the octahedral meteoric irons and their relationship to the Widmanstätten structure has been made. In Cañon Diablo, 15 crystals belonging to the macroscopic Widmanstätten structure were separately examined. These showed small deviations from the 24 orientations of the type: (110)-kamacite parallel to (111)-octahedrite, [001]-kamacite inclined at 4°·1, (μ), to [110]-octahedrite. In the Butler and Carlton meteorites, the microscopic Widmanstätten structure was examined. The taenite crystals showed a very strongly preferred single orientation identical with that of the octahedrite, while the kamacite crystals were orientated in the same way as those in Cañon Diablo. In a heat-treated artificial nickel-iron, containing 10% of Ni, the orientations of the γ-phase and α-phase constituents were found to be similar to those of the taenite and kamacite, respectively, in the meteoric irons. The value of μ (3°·4), however, was somewhat lower. In all cases in which μ could be determined with some precision the orientation of an α-phase crystal lay between that found by Nishiyama and that proposed by Kurdjumow and Sachs. An attempt is made to account for the orientations found by supposing that the γ-α transformation proceeds according to a lattice mechanism of the Nishiyama-type modified by the effect of temperature agitation. Reasons are given for supposing that the orientations for which $\mu = 0°$ and $\mu = 5°\ 16'$ involve high potential energies at the kamacite-taenite interface and the consequent avoidance of such orientations of the kamacite crystals. These orientation studies give the most convincing proof that the body-centred α-crystals of kamacite are the result of a precipitation from a single face-centred γ-lattice of uniform orientation whose axes are those of the octahedrite. The distortion of the Widmanstätten structure was also examined. It is shown that the bulk distortion of the Widmanstätten structure and the rotations of individual crystals are consistent with the effects of plastic shearing of the whole portion of meteorite examined. Author.

604. β-β transformation in Li-Pb alloys. T. C. Wilson. *J. Chem. Phys.*, **8**, *pp.* 13–19, *Jan.*, 1940.—Measurements made by Grube and Klaiber in 1934 on the alloys of Li and Pb indicate that a transformation of peculiar character occurs in the β-phase of these alloys. The behaviour of this transformation under high hydrostatic pressure has been investigated

by measurements of the electrical resistance. The results, together with those from rough thermal expansion measurements, indicate that the transition takes place gradually on heating from a phase of abnormally high energy and entropy content to a phase of more normal character. X-ray analyses suggest that the transition is accompanied by movements of the Li atoms in the lattice to more orderly positions. AUTHOR.

605. Structure of solid HF. P. GÜNTHER AND K. HOLM. *Zeit. f. phys. Chem. Abt.B*, **44**, 5–6, *p.* 474, 1939.—Referring to their previous work [see Abstract 3501 (1939)] the authors point out that before the work of Bauer, Beach, Simons and Hildebrand, it had been shown by K. Fredenhagen from experiments on the measurements of vapour densities that the assumption of molecular chains in gaseous HF did not agree with facts. He came to the conclusion that the course of the dissociation isotherm could only be explained by the presence of a series of molecular aggregates. G. G.

606. Structure of complex cyanides. A. M. ROLLIER AND E. ARREGHINI. *Gazz. Chim. Ital.*, **69**, *pp.* 499-508, *Aug.*, 1939.—Methods of preparing (green) $Cu_3[Co(CN)_6]_2$, and coarsely crystalline (green) $Cu_2Cr(CN)_6$ are described. Powder photographs of the materials stuck to a glass thread 0·15 mm. in dia., in a camera 57·3 mm. in dia., with Cu radiation and Ni filter gave the following results :—The unit cell is cubic in both cases, $a = 9{\cdot}91 \pm 0{\cdot}05$ and $10{\cdot}22 \pm 0{\cdot}05$ Å, $z = 2$ and 4, the space group is O_h^5, in essentials the structure is identical with that of many other complex cyanides with di- and tri-valent kations [see Abstract 1884 (1939)]. After drying for 24 hr. at 20 mm. over P_2O_5 the following water contents were observed : $Cu_2Fe(CN)_6$ 30·8%, $Cu_3[Co(CN)_6]_2$ 24·4%, $CuK_2Fe(CN)_6$ 1·5% ; for these salts at about 18°C. χ was found to be 5·99, 5·60 and $3{\cdot}80 \times 10^{-6}$ respectively, and the magnetic moment per gm. Cu 1·86, 1·91 and 1·81 Bohr magneton units (1·73 ≡ 1 electron spin). This confirms that all the Cu is present in divalent form and that paramagnetism from the other metallic atom does not occur in these compounds ; the author's results are in agreement for the " poly-nuclear complex " suggested for the structure. D. R. H.

607. Structure of potassium sulphamate. C. J. BROWN AND E. G. COX. *Chem. Soc., J., pp.* 1–10, *Jan.*, 1940.—A complete determination of the crystal structure of potassium sulphamate, $NH_2{\cdot}SO_3K$, has been made by means of three-dimensional Fourier syntheses. The three O atoms and the N atom in the $[NH_2{\cdot}SO_3]'$ group are arranged in an almost regular tetrahedron around the S atom, the bond lengths being S–O = 1·44 Å and S–N = 1·57 Å (both ± 0·03 Å). The structure appears to be purely ionic and there is no evidence of hydrogen bridges between neighbouring anions. Although the position of the H atoms cannot be determined directly, there is very strong evidence that they are attached to N and not to O atoms. AUTHORS.

608. X-ray study of phthalocyanines. Part IV. Direct quantitative analysis of Pt compound. J. M. ROBERTSON AND I. WOODWARD. *Chem. Soc., J., pp.* 36–48, *Jan.*, 1940.—By substituting an atom of high atomic number at some point in a complex organic structure a very direct method of X-ray analysis becomes available. This has often been utilized, but rarely in a fully quantitative manner. The possibilities of the method are discussed, and it is concluded that it may have almost unlimited application. At the same time there are serious practical difficulties. A critical test of the method is made in the analysis of platinum phthalocyanine, $C_{32}H_{16}N_8Pt$, with quantitative intensity measurements, corrections for absorption, dif-

fraction effects, etc. The positions of all the atoms (except H) in this structure are determined with an average accuracy of about $\pm$ 0·05 Å. A double Fourier series of 302 terms is employed for this purpose. The molecular structure, as expected, is closely similar to that of the other members of the phthalocyanine series, although certain small changes in dimensions, due to the presence of the Pt atom, are noted. The crystal structure, however, is different, because the molecules are arranged in a different way, their planes being inclined at a much smaller angle to the (010) plane (26·5° instead of 44·2°). The structure may be regarded as a polymorphic modification of those already described in this series. [See Abstract 1464 (1937).] AUTHORS.

609. Crystallite growth during carbonization. H. E. BLAYDEN, H. L. RILEY AND A. TAYLOR. *Am. Chem. Soc., J.*, **62**, *pp.* 180–186, *Jan.*, 1940. —Investigations previously reported [see Abstract 916 (1939)] for the temperature range 400–1 300° were extended to 2 200° to include 1 American and 2 Welsh anthracites, lignin, and an Irish peat. The anthracites and the peat all show anomalies in their crystallite growth curves. The anthracite crystallites show a decrease in the *c* dimension as the carbonization temperature is increased from 400 to 900°, and this is interpreted as due to disruption of the crystallites. The peat coke crystallites show a very rapid growth in the *c* direction between 700 and 1 000° which is probably due to a catalytic effect. The significance of the results is discussed in detail. N. M. B.

See also Abstracts 594, 597, 618, 619, 650, 720, 758, 765, 789, 791, 793, 795, 809, 810, 857, 894, 896, 897, 898, 899.

DENSITY.

See Abstracts 648, 825, 826.

DIFFUSION AND OSMOSIS.

610. Diffusion of elements in Al. A. BEERWALD. *Zeits. f. Elektrochem.*, **45**, *pp.* 789–795, *Nov.*, 1939.—In continuation of work by Seith and collaborators [see Abstract 75 (1936)] it is reported that difficulties occur with Al, on account of its weakness and oxidizability at high temperatures; a method of holding the two specimens together *in vacuo* by a spring is described, but with too great pressure, distortion occurs, and with too little, welding will not take place. The results follow the general expression $D = Ae^{B/RT}$ with the following values of A and B respectively: for Cu 7 250 and — 32 600, for Mg 10 200, and — 28 600, for Ag 95 400 and — 32 600, for Zn 1 000 000 and — 27 800, for Si 77 800 and — 30 550, for Mn no welding occurred and only qualitative evidence could be obtained. Of the 4 empirical rules connecting diffusion in Pb and Ag with (*a*) atomic radius, (*b*) difference in number of valency electrons, (*c*) solid solubility, (*d*) heat of solution, of the respective elements, only (*c*) is valid for diffusion in Al. Data are tabulated for the range 400–500°C., the concentrations being determined spectroscopically. D. R. H.

611. Osmotic pressure and solvent state in system acetone-nitrocellulose. C. G. BOISSONNAS AND K. H. MEYER. *Zeits. f. phys. Chem. Abt. B.*, **44**, 5–6, *pp.* 392–396, 1939.—It is shown that the experimental data of G. V. Schulz [see Abstract 2691 (1938)] on osmotic pressures in the system acetone-nitrocellulose are faulty and therefore not valid for the calculation of heats and entropies of dilution. H. H. Ho.

See also Abstracts 581, 582, 583, 584, 585.

ELASTICITY AND PLASTICITY.

612. Elastic deformation in two semi-infinite solids. G. Lundberg. *Forsch. IngWes.*, **10,** *pp.* 201–211, *Sept.–Oct.*, 1939.—A general solution of the problem of the elastic displacements in a semi-infinite elastic solid due to normal and shear stresses distributed over its plane boundary is given. The solution is applied to determine the pressure distribution and deformations in two bodies in contact, leading to an integral equation to determine the former. The detailed solutions are given for the cases of a cylinder of finite length, and of portions of a cone, on the assumption of uniform stress distribution along their length. W. G. B.

613. Warping of flat strips whose thickness changes by stages. F. A. Willers. *Forsch. IngWes.*, **10,** *pp.* 227–234, *Sept.–Oct.*, 1939.—The equation is derived for calculating the warping load of a flat strip with constant section-thickness, and the two-dimensional case is very thoroughly investigated. It follows that, in general, strips of invariable thickness for the same amount of material are more safe against warping than those which are graded. Only for graded strips capable of turning on both sides does a region exist in the middle, which, when strengthened, is more secure against warping. From cases where the stages are not too pronounced, it is shown how the warping load may be determined approximately for strips of variable thickness. The paper is entirely mathematical. H. H. Ho.

614. Stress functions for a plate containing groups of circular holes. R. C. J. Howland and R. C. Knight. *Roy. Soc., Phil. Trans. A,* **238,** 793, *pp.* 357–392, *Nov.* 24, 1939.—A number of solutions of the biharmonic equation have been obtained, mostly in connection with the problems of generalized plane stress, when the boundaries have consisted of circles and straight lines. No general method of solution can be given but the methods which the present authors have used in certain cases are here extended to a group of problems. The paper deals with circles in (*a*) the infinite plane, (*b*) a strip bounded by parallel lines. The circles, their number and relative positions, are restricted by an invariancy condition, which demands that the circles and their boundary conditions remain invariant under one or more of a group of transformations and/or reflections. In (*a*) the configurations have the boundaries (i) one pair of circles, (ii) two pairs of circles, (iii) a double infinite row of circles. While in (*b*) (i) one pair, and (ii) two pairs of circles are dealt with. These together with solutions previously published complete the group of problems to which the method is applicable. No numerical work is included but the expansions of the necessary functions have been determined. They may be used for any problem where the biharmonic equation has to be solved with the appropriate boundaries. The method of solution when the required functions have been established is indicated. Authors.

615. Elasticity theory of finite displacements. Part I. R. Kappus. *Zeits. f. angew. Math. u. Mechanik,* **19,** *pp.* 271–285, *Oct.*, 1939.—The theory of elastic stability, developed by Treffertz [*ibid.* 13, *pp.* 160–165, 1933] and concerned principally with elastic deformations in which the relation between stress and strain is non-linear is further extended by the application of tensor theory. Illustrative examples of the application of the theory to the finite torsion and bending of a rod are to be given in a continuation of the paper. J. S. G. T.

616. Stability of a catenoidal shell. K. Federhofer. *Akad. Wiss. Wien, Ber.*, **148,** 2a, 1–2, *pp.* 67–80, 1939.—The elastic equilibrium of a catenoidal shell, bounded by two parallel circular sections and subjected to a uniform compression, is discussed mathematically. J. S. G. T.

617. Calculation of eigenvalues of axial-symmetrical oscillations of hollow cylinders. J. Lennertz. *Zeits. f. angew Math. u. Mechanik*, **19,** *pp.* 286–289, *Oct.*, 1939.—The eigenvalues of torsional axial-symmetrical oscillations of a hollow cylinder are readily determined in all cases; their calculation in the case of coupled longitudinal and radial oscillation is more difficult, the solution depending upon solving the periodic equation given by Ghosh. It is shown that in the case of such coupled oscillations there are 2 series of eigenvalues. The one series yields good approximations for the case of pure longitudinal oscillations, characterized by small frequencies. The second series yields large frequencies; in the case for which the length of the cylinder is large compared with the internal and external radii of the cylinder the solution furnishes approximate values for pure radial oscillations. J. S. G. T.

618. Behaviour of crystal structure of brass under slow and rapid cyclic stresses. W. A. Wood and P. L. Thorpe. *Roy. Soc., Proc. A*, **174,** *pp.* 310–321, *Feb.* 15, 1940.—The stress-extension relationships for an annealed α-brass have been measured for static tensile stress and for a symmetrical alternating tension-compression applied at a frequency of 2 200 c./min., and the mechanical properties indicated by the curves have been studied in relation to the changes in crystalline structure of the grains as shown by the X-ray diffraction method. It is shown that the dispersal of the grains into widely oriented crystallites, which constitutes the physical characteristic of the change at the yield point under ordinary static or slow cycle stress, is entirely suppressed under the same ranges of cyclic stress when applied at the high frequency, and that, after the cyclic stressing has ceased, this suppression persists up to a static load equal to the maximum of the prior stress cycle employed; the mechanical measurements indicate a corresponding inhibition of the primitive yield point. A further result is obtained by a precise comparison of the dimensions of the atomic lattice of specimens subjected to cycles of an unsafe range of stress; these show that an appreciable internal strain of the nature of a volume expansion is built up in the lattice during the rapid cyclic stressing and it is considered that it is this distortion which is associated with the inhibition of the dispersed crystallite formation and rise in primitive static yield point. Authors.

619. Internal strains in solids. *Phys. Soc., Proc.*, **52,** *pp.* 1–178, *Jan.*, 1940.—Report of a conference on the subject, comprising 19 contributions.

PART I. SLIP IN SINGLE CRYSTALS.

"Glide and hardening in metal single crystals," by E. N. da C. Andrade (*pp.* 1–7).—A survey of recent experimental work on slip in single crystals of metal. Temperature has a great influence on the plastic properties, and the behaviour of different metals with the same crystal structure depends mainly on the ratio of the experimental temperature to the melting point of the metal. Results are discussed in terms of the dislocation theory of slip.

"Problems of plastic gliding," by E. Orowan (*pp.* 8–22).—A discussion of the rate of flow in metal single crystals. Flow is believed to be

due to the presence of dislocations; the rate of production and rate of movement of dislocations are treated.

"Geometrical considerations on assumed structural irregularities in a crystal," by J. M. Burgers (*pp.* 23–33).—A description of investigations of the geometrical and mechanical properties of some types of dislocation the motion of which through the lattice has been assumed to propagate slip. It is shown that plane systems of simple dislocations can break up a crystal into Bragg-type mosaic pattern crystallites.

"Size of a dislocation," by R. Peierls (*pp.* 34–37).—Calculations are made of the size of a dislocation and of the critical shear stress for its motion.

"Theoretical problems of the solid state," by J. E. Lennard-Jones (*pp.* 38–53).—A discussion of unsolved theoretical problems. One of these is the occurrence of small crystallites even in the most perfect crystals, and reasons are given for attributing such imperfections to the conditions of growth from the melt. A study of conditions at the boundaries between crystallites might throw light on slip and on the appearance of slip bands, properties not yet adequately explained. The nature of melting and solidification require further study. Local melting may occur in crystals owing to slip and be a factor in producing strain hardening. A method is given of evaluating the relation between stress and strain outside the usual elastic limits and at temperatures approaching the melting point.

"Discussion" (*pp.* 54–57).—Contributions by W. L. Bragg, W. A. Wooster, W. G. Burgers, and a summary, by N. F. Mott, of some of the points of view expressed.

PART II. PRECIPITATION IN METALS AND AGE-HARDENING.

"Diffusion in solids," by R. M. Barrer (*pp.* 58–70).—A summary and discussion of data on diffusion constants in ionic and metallic systems in terms of the Fick-Matano diffusion equation $D = D_0 e^{-E/RT}$. Theories of diffusion are outlined, and expressions for the diffusion constant and its relation to other physical quantities are considered. Similarities between diffusion and chemical reaction are brought out by considering the entropy of activation and periodicity curves for D_0.

"Formation of nuclei during precipitation," by R. Becker (*pp.* 71–76).—When an alloy in which precipitation is to take place is cooled, the process begins with an observable velocity only when the temperature has fallen by a definite amount below that at which the single-phase alloy is in equilibrium. This fact is explained by a theory of nuclear formation. Calculation of the rate of formation of nuclei is examined.

"Age-hardening of Cu-Al alloys," by G. D. Preston (*pp.* 77–79).—The ageing of Al alloys containing 4% of Cu is discussed. At room temperature the Cu atoms segregate on the (100) planes of the crystal, but no new phase is formed. At 200° a pseudomorphic form of $CuAl_2$ is precipitated.

"X-ray evidence of intermediate stages during precipitation from solid solution," by A. J. Bradley (*pp.* 80–85).—Intermediate metastable structures resulting from the partial decomposition of solid solutions have been found in the Cu-Ni-Al, Fe-Ni-Al, and Fe-Cu-Ni systems. In each case a single-phase structure, stable at high temperatures, breaks up into two phases on cooling. The first stage of the decomposition is the formation of islands, in which atoms are segregated prior to precipitation. Islands of $CuNi_2Al$ segregate from a Cu-rich solid solution. Islands of Fe-Ni-Al segregate from a Fe-rich solid solution, and these islands are recognized by the

formation of the superlattices characteristic of the precipitating phases. During the decomposition of Fe Cu_4 Ni_3 into two phases, a laminated structure is produced, in which Cu-rich laminae alternate with laminae rich in Fe and Ni. Each has a tetragonal structure with the same a axes as in the former solid solution ; in the Cu-rich laminae $c > a$; in the other $c < a$.

" Estimation of degree of precipitation hardening," by N. F. Mott and F. R. N. Nabarro (*pp.* 86–89).—The process of diffusion being assumed to result simply in an interchange of atoms, an estimate is made of the internal strains produced by precipitation. On the dislocation theory these strains are responsible for the hardness of the material, and so the degree of hardening can be predicted.

" Influence of elastic strain on the shape of particles segregating in an alloy," by F. R. N. Nabarro (*pp.* 90–93).—An estimate is given of the dependence of the strain energy associated with a particle of precipitate on the shape of the particle. It is shown that the energy can be reduced only if the precipitate forms in flat plates, and then only in the case of particles which have broken away from the lattice of the matrix. This dependence of strain energy on shape causes the precipitate to consist of plates of a shape similar to that observed in Widmanstätten structures.

" Discussion " (*pp.* 94–104).—M. L. V. Gayler described plates of the intermediate phase in a high-purity Al alloy containing 4% of Cu, and aged for 27 days at 250°. It is shown definitely that the transformation from the intermediate phase to $CuAl_2$ is polymorphic. G. Wassermann discussed the influence of quenching strains on age hardening. Contributions were also made by L. Frommer, E. Orowan, W. G. Burgers, W. H. Taylor and N. F. Mott.

PART III. POLYCRYSTALLINE METALS AND THE EFFECT OF COLD WORK.

" Structure of a cold-worked metal," by W. L. Bragg (*pp.* 105–109).—Evidence is presented in favour of the suggestion that a cold-worked metal is in dynamical rather than statical equilibrium. An analogy with the state of affairs in superlattices is made.

" Crystalline structure and deformation of metals," by W. A. Wood (*pp.* 110–116).—From observations by a combination of mechanical, metallographic, and X-ray tests, a survey is made of changes in crystalline structure of polycrystalline metals and large single crystals subjected to deformation by cold-work and by static and cyclic stressing. It is shown that the grains may be dispersed into crystallites characterized by a lower limiting size depending on the metal, and that internal lattice strains, considered to be related to the process of strain hardening, can be observed. The response of the crystalline structure is shown to depend on the manner and particularly the speed of application of stress, and it is thus possible to inhibit the dispersed crystallite formation and suppress the primitive yield-point of a metal, thus varying the hardness independently of the external deformation.

" Lattice distortion in cold-worked metals," by G. W. Brindley (*pp.* 117–126).—Measurements of the intensities of X-ray reflections from cold-worked metals indicate that in this respect the lattice distortion resembles a frozen heat motion. It is shown that with filed powders of Cu, Ni, and Rh, the intensity effect decreases in this order. Measurements of the widths of the reflections from Cu, Ni, and particularly Rh, are discussed in relation to various theories of broadening (which is shown to increase in

the above order) of X-ray reflections. It is satisfactory to suppose that the mean lattice parameter varies from one crystallite to another. The question why an increase in the intensity effect is accompanied by a decrease in the broadening of the reflections, and the relation of these phenomena to the cohesional properties of the metals is briefly considered.

" Mechanical effects of inter-crystalline boundaries," by B. CHALMERS (*pp.* 127–131).—The effect of a single crystal boundary on the critical shear strength of a metal is investigated.

" Mechanism of glacier flow," by M. F. PERUTZ (*pp.* 132–135).—An examination of the crystal textures of snow and ice from Alpine glaciers, and strain measurements within the glaciers show that under the influence of glacier flow, a compact snow (firn) covering the upper regions of glaciers is deformed through relative motion of individual ice crystals, whereas the ice forming the bulk of the glacier yields by crystal deformation and crystal growth and also by slip over large thrust planes.

" Discussion " (*pp.* 136–137).—Contributions by E. OROWAN and W. G. BURGERS.

PART IV. OTHER EFFECTS OF INTERNAL STRAINS.

" Internal strains and magnetism," by R. BECKER (*pp.* 138–151).—The magnetic properties from which a numerical value can be obtained for the internal stress are collected together, and the 180° walls, which play a decisive part on the understanding of the coercive force, are considered in detail. Their energy is determined theoretically and experimentally.

" Internal friction in solids," by C. ZENER (*pp.* 152–166).—The various causes occur owing to the inhomogeneous strains set up by the vibrations in the solid, and to the variations in the elastic constants from point to point in polycrystalline materials. The influence of ferromagnetism also is considered.

" X-ray diffraction by finite and imperfect crystal lattices," by P. P. EWALD (*pp.* 167–174).—A discussion of the Fourier transform of a crystal. This is a representation which, if fully known, would be equivalent to, and give the same information as, the usual description of a crystal. It is very closely related to the diffraction properties and offers the best survey of the diffraction data obtained, and of those missing, for a discussion of crystal shape and imperfection [see Abstracts 11 and 12 (1940)].

" Discussion " (*pp.* 175–178).—Contributions by E. C. STONER, F. PREISACH and W. G. BURGERS. N. M. B.

See also Abstract

216B. Definition of permanence of strength of Al alloys. F. v. Göler and W. Jung-König.

HYDRODYNAMICS AND AERODYNAMICS.

620. New method of evaluating the flow in a boundary layer which varies with time. T. SAKURAI. *Phys. Math. Soc. Japan, Proc.*, **21**, *pp.* 632–637, *Nov.*, 1939.—The paper considers the problem of the two-dimensional flow in a boundary layer of viscous fluid produced by motion of the wall, with special reference to the cases where (*a*) the velocity is not regarded as simple polynomials in time and (*b*) the boundary layer is not initially at rest. Blasius' method is not successful for these two latter cases, but the new method provides accurate solutions. The paper discusses the evaluation at the commencement of flow and of the change of state of flow. [See following Abstract.] S. A. S.

621. Two-dimensional boundary-layer equation for motion of viscous fluid near moving obstacle. T. Sakurai. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 707–712, *Nov.*, 1939.—The author derives a new boundary-layer equation expressing the law of general two-dimensional motion of a viscous fluid in the boundary layer near a moving obstacle and it is considered this equation enables solutions to be obtained to many important practical problems, which cannot be solved by Prandtl's equation. The boundary-layer equation is first deduced from Navier-Stokes' equations expressed in terms of x, y, rectangular co-ordinates, for a region in the neighbourhood of a given point and subsequently curvilinear co-ordinates are employed in order to make the equation applicable to flow everywhere in the boundary layer. [See preceding Abstract.] S. A. S.

622. Velocity distribution of turbulent flow near the wall and in the pipe. K. Takahasi. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 672–678, *Nov.*, 1939.—Values of the thickness of the boundary sub-layer and of the viscous layer in turbulent flow are derived on the assumption that the stresses due to turbulence and viscosity are additive and their sum, (τ), is given by $\tau = \rho(\nu + l^2\, du/dz)\, du/dz$. The viscosity distribution in a circular pipe is derived, and it is shown that the effect of viscosity is negligible except in the immediate neighbourhood of the wall. Empirical results are shown to agree better with deductions from Taylor's vorticity transport theory than with those from the momentum transport theory, even when viscosity is taken into account. J. S. G. T.

623. Mathematical theory of irrotational translation waves. G. H. Keulegan and G. W. Patterson. *Bureau of Standards, J. of Research*, **24,** *pp.* 47–101, *Jan.*, 1940.—This paper is the first of a series dealing with the motion of flood waves and other waves of translation in open channels. The case treated is that of waves for which the forces of fluid friction are negligible with respect to the inertia and gravitational forces. The irrotational motion of a perfect liquid in a horizontal rectangular canal when the original surface is disturbed is investigated on the assumption that the horizontal velocity in a cross-section is approximately uniform. The results are also applicable to motion in a canal of uniform slope containing water originally moving with a uniform velocity. Special emphasis is laid on disturbances which are propagated without change of form, and in these cases formulae are derived for the wave profile and velocity of propagation. Formulae are also derived which give the deformation, energy, motion of the centre of gravity, and moment of instability of an arbitrary intumescence. Consideration is given to the maximum height of a wave of permanent form. Formulae have been compared with the available experimental data. Of special interest is the comparison of the shape of the undulations composing the head of an initial surge with the characteristics of the cnoidal wave.

624. Flow pictures showing influence of the ground. H. Müller. *Forsch. IngWes.*, **10,** *pp.* 220–226, *Sept.–Oct.*, 1939.—The pictures show flow-patterns for various obstacles resting on the "ground." The roughness of the upstream "ground" has considerable influence on flow and resistance. A quantitative experimental study is made of the effect of radial fins fore and aft of a circular cylinder, and details of the pressure distribution round the cylinder are given. W. G. B.

See also Abstract 702.

KINETIC THEORY OF MATTER.

625. High-velocity atomic beams. I. Amdur and H. Pearlman. *J. Chem. Phys.*, **8**, *pp.* 7–12, *Jan.*, 1940.—A general method has been developed for the production and intensity measurement of high-velocity atomic beams. The method has been applied to beams of H atoms with energies equivalent to 200-800 V electrons. Measurement of the collision cross-section of these atoms when scattered by molecular H_2 confirms the prediction that such scattering is predominantly due to repulsive forces between the beam and scattering particles. Authors.

626. Brownian molecular movement. E. Kappler. *Naturwiss.*, **27**, *pp.* 649–658, *Sept.* 29, *and pp.* 666–670, *Oct.* 6, 1939.—This paper gives a comprehensive review of work on the Brownian movement. Following an historical introduction, 7 sections deal with the subject matter as follows: —(1) The molecular movement itself; (2) force-free Brownian movement; (3) influence of external forces, both constant and elastic; (4) Brownian movement *in vacuo*; (5) importance of Brownian movement for measurement technique; (6) naked-eye observations of the phenomenon; (7) Brownian movement and statistics. The treatment includes 46 literature references and 9 diagrams, while the paper as a whole is a most useful summary of this very important subject. H. H. Ho.

See also Abstract 654.

LENGTH, AREA AND VOLUME.

***627. Geometry of optical indicators.** K. J. DeJuhasz. *Frank. Inst., J.*, **229**, *pp.* 53–80, *Jan.*, 1940.—Optical indicators are employed widely in physics and engineering for the magnification and measurement of small distances, small and rapid motions, and rapidly varying pressures, forces, currents and voltages. This paper analyses and describes the geometrical principles underlying the optical magnification and it discusses the requirements and desiderata for their most advantageous realization in actual instruments. The sections of the paper are the optical lever, kinematic considerations, optical levers with one degree of freedom of rotation, application of the theorem of the transposed cone to particular cases, non-spherical screens, convergent light beams, mirror support, and critique of actual optical indicators. In the latter section several actual indicators are illustrated by sectional arrangement line drawings. S. A. S.

See also Abstract 596.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

628. New properties of Bohr almost-periodic Fourier series. S. Takahashi. *Japanese Journ. Math.*, **16**, 2, *pp.* 99–133, *Sept.*, 1939.—Two problems in the theory of Bohr almost-periodic Fourier series are not yet completely solved, viz.: (1) The necessary and sufficient condition that a given trigonometric series $\Sigma A_n e^{i\lambda_n x}$ represents a Bohr almost-periodic Fourier series. (2) The decision of the existence or non-existence of some inner conditions under which the partial sums of a given Bohr almost-periodic Fourier series or function may converge in the neighbourhood of a point or in an interval. The present paper deals with certain aspects of these problems. Part I, which discusses operations with Fourier series, considers the formal differentiation and integration of Fourier series, and conjugate Fourier series. Part II deals with the summation of Fourier

series of Bohr almost-periodic functions by partial sums and includes some theorems concerning quasi-regular functions. The paper is entirely mathematical and contains a very complete bibliography of the subject. H. H. Ho.

629. Correlation between tensor quantities. M. MASUYAMA. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 638–647, *Nov.*, 1939.—The theory of correlation is used mainly in studies of biology, social economics, etc., in which sciences tensor quantities seldom appear and, probably because of this, the phenomena represented by tensors have not been dealt with. In physics, and especially in geophysics, the relationship between two or more tensor quantities and sometimes two or more tensor fields must be investigated. The present paper shows the procedure for doing this. S. A. S.

630. Tensor characteristic of vector set and its application to geophysics. M. MASUYAMA. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 647–655, *Nov.*, 1939.—Scalar or vector quantities such as mean (scalar) wind velocity or mean (vector) wind velocity have been used in climatological routine work as the characteristic quantities of a set of wind vectors and in this paper a tensor quantity is proposed as the characteristic referred to. If $\left\{ \begin{matrix} {}^{t}s \\ \mathrm{V}\alpha \\ \alpha \end{matrix} \right\}$ represents a set of wind vectors observed at a point in a certain period of time or concurrently in a given region, the problem with which the paper is concerned is that of studying the tensor $[\mathrm{V}_i\mathrm{V}_j]$ as a characteristic of the vector set $\left\{ \begin{matrix} \mathrm{V} \\ \alpha \end{matrix} \right\}$ where $[\mathrm{V}_i\mathrm{V}_j] = \sum_{\alpha=1}^{n} \mathrm{V}_{i\alpha}\mathrm{V}_{j\alpha}$. S. A. S.

631. Asymptotic expansion of integral functions defined by Taylor series. E. M. WRIGHT. *Roy. Soc., Phil. Trans. A*, **238,** *pp.* 423–451, *Jan.* 23, 1940.

632. Dimensions of electromagnetic quantities. A. SOMMERFELD. *Ann. d. Physik*, **36,** 3–4, *pp.* 335–339, *Oct.*, 1939.—The author derives the dimensions of electromagnetic quantities based on a system of 4 and a system of 5 fundamental units. The units chosen are the metre, kilogramme, second, and units of electric charge and pole strength. Although the fifth of these is not very suitable from the point of view of technical measurements, the author considers that a complete understanding of the question of dimensions requires the inclusion of this unit or an equivalent. [See Abstract 94 (1936).] G. E. A.

***633. Mechanical integration of differential equations.** S. ROSSELAND. *Naturwiss.*, **27,** *pp.* 729–735, *Nov.* 3, 1939.—An account is given of the differential analyser constructed at the Astrophysical Institute, Oslo. The machine is a much larger and slightly modified form of the original differential analyser designed and constructed by Bush. The analyser is stated to have the largest capacity of those yet constructed. There are 12 integrators, in pairs, each pair driven by a separate motor, and 7 tables which can be used as either input or output tables. In spite of its large capacity the machine is very compact. The tables are mounted in line without gaps between them, and the pairs of integrators are very close together. Mechanical torque amplifiers, frontlash units and adding units are incorporated, and are similar in design to, or slightly modified versions of, those in the Bush and Hartree models. Automatic curve followers are not used. The solutions are recorded graphically but it is planned to

add a photographic recording device and a special table for polar co-ordinates. The author gives examples of the type of differential equation easily solved on the differential analyser and the solutions obtained in certain particular cases are shown in the form of curves. The large capacity of the Oslo differential analyser would allow the restricted 3-body problem, a problem of great interest to astronomers and which would require 10 integrators, to be treated mechanically for the first time. S. W.

***634. Simple multi-speed pencil polygraph.** K. J. W. Craik. *Journ. Sci. Instruments*, **17**, *pp.* 38–39, *Feb.*, 1940. The polygraph described offers a wide range of speeds by means of a special gear-box, a clean, reliable method of recording by pencils, and a high resolving power, up to 100 impulses per second. It could be adapted for use with valve amplifiers for recording physical phenomena up to this speed, or the pencils could be moved mechanically by cords or Bowden wires to indicate continuously the positions of mechanical moving parts. Author.

See also Abstract 843.

MECHANICS, CLASSICAL.

635. Stability of motion of pendulum with oscillating point of suspension. K. Klotter and G. Kotowski. *Zeits. f. angew. Math. u. Mechanik*, **19**, *pp.* 289–296, *Oct.*, 1939.—A mathematical investigation of the stable and labile " equilibrium " positions of a pendulum, the point of suspension of which is subjected to a harmonic motion, yields results in agreement with those obtained by some previous investigators (Greenhill, Hirsch, Klotter) while differing from those obtained by others, e.g. Erdélyi. It is suggested that the problem merits attention *de novo*. J. S. G. T.

636. Potential momentum and momentum fields in dynamics. W. H. Watson. *Canad. J. of Research, Sect. A*, **18**, *pp.* 1–21, *Jan.*, 1940.—Based on previous work of the writer [see Abstract 895 (1935)] this paper deals with the specification of dynamical systems *via* potential momentum and momentum fields, and setting out from the continuous motion formally identical with the meson → electron transformation, opens the study of systems of motions of a single particle defined by $dP_\varrho/ds = F_{\varrho\sigma}dx_\sigma/ds$, where $F_{\varrho\sigma}$ is not an antisymmetric tensor. Fields which, in addition to the usual electromagnetic effects, change the rest-mass of a particle moving under their action, and are caused by the creation or destruction of electric charge, are proposed as the classical model for neutrino radiation. Author.

MECHANICS, QUANTUM.

637. Existence of smallest time interval. F. Möglich and R. Rompe. *Zeits. f. Physik*, **113**, 11–12, *pp.* 740–750, 1939.—Following the assumption of a smallest time interval, it seems indicated to describe the motion of a mass point in difference equations. These equations are solved for two cases, (1) for the case that the acting force is an impulse and (2) for the harmonic oscillator. In the latter case it is shown that the damping of the harmonic oscillator agrees with the classical damping. The energy of the oscillator is no longer independent of the time. But it is possible to prove that the variation of the energy with time is equal to a term which describes the energy emission by the electromagnetic field in classical electrodynamics. L. K.

See also Abstracts 663, 882, and

307B. Quantum physics of solids. Part I. Energies of electrons in crystals. W. Shockley.

PRESSURE.

See Abstracts 700, 710.

RELATIVITY AND ETHER.

638. Axially-symmetric gravitational field. B. C. Mukerji. *Calcutta Math. Soc., Bull.*, **31**, *pp.* 63–68, *June*, 1939.—Silberstein's result, that a non-static axially-symmetric field is impossible, is shown to hold only if there is a hydrostatic pressure in a plane normal to the axis of symmetry and also if there is no flow of momentum in the same plane. The field of an infinite material plane moving perpendicular to itself with constant velocity is worked out and shown to give a non-static axial field which does not come under the form assumed *a priori* by Silberstein. G. C. McV.

639. General theory of relativity and principle of equivalence. K. Sapper and C. F. v. Weizsäcker. *Phys. Zeits.*, **40**, *pp.* 663–667, *Nov.* 1, 1939.—Sapper discusses some difficulties arising from the postulate of the equivalence between the events in an accelerated system and a system at rest in a gravitational field, principally the measurements of the velocity of light in two such systems which should lead to equal results according to Einstein. Weizsäcker refers to the case that a clock accelerated with the accelerated system is equivalent to a free falling clock in the gravitational field. If the clock, however, is at rest in the gravitational field, the corresponding clock is at rest with respect to the accelerated system. Here the special theory of relativity does not hold; the principle of relativity establishes the assumption to be made about the period of the clock, and measurements of the velocity of light depend on the place where they are made. L. K.

640. General relativity and flat space. Parts I and II. N. Rosen. *Phys. Rev.*, **57**, *pp.* 147–153, *Jan.* 15, 1940.—Within the framework of the general theory of relativity, it is proposed to introduce at each point of space-time a Euclidean metric tensor $\gamma_{\mu\nu}$ in addition to the usual Riemannian metric tensor $g_{\mu\nu}$. In this way tensor character is imparted to quantities which in the usual form of the theory do not have it. For example, a gravitational energy-momentum density tensor can be obtained in place of the usual pseudo-tensor. Furthermore four additional covariant conditions can be imposed on the gravitational field and thus restrict the form of the solution for the field corresponding to a given physical situation. In Part II the possibility is considered of interpreting the formalism of the general theory of relativity in terms of flat space, the fundamental tensor $g_{\mu\nu}$ being regarded as describing the gravitational field but having no direct connection with geometry. The resulting theory in general leads to the same predictions as the Einstein theory, but there are cases where the predictions differ. The present theory may explain the principal results obtained by D. C. Miller in his "ether-drift" experiments. The implications of the theory for cosmology are briefly touched upon. [See following Abstract.] Author.

641. Ether-drift experiments. N. Rosen. *Phys. Rev.*, **57**, *pp.* 154–155, *Jan.*, 1940.—It is shown that it is possible to account for the principal results obtained by Miller [see Abstract 3366 (1933)] in his "ether-drift" experiments, on the basis of a flat-space theory of gravitation, as due to the motion of the earth in the gravitational field of all the matter and energy in the universe. [See preceding Abstract.] Author.

SOLUTION.

See Abstracts 652, 828.

SURFACE PROPERTIES.

642. Sorption of oxygen by active carbon. R. Juza and R. Langheim. *Zeits. f. Elektrochem.*, **45**, *pp.* 689–698, *Sept.*, 1939.—Magnetic methods have been used to study the sorption of O_2 on active C. Gaseous and molecularly adsorbed O_2 are strongly paramagnetic, but the first O_2 to be adsorbed, probably as a surface oxide layer, loses its paramagnetism. The formation of this primary layer and its variation with time, quantity of adsorbed O_2, and temperature (18 — 200°) have been investigated. The adsorption is a reaction of zero order. An apparatus for determining susceptibilities at low temperatures is described. Observations can be carried out in any desired atmosphere. The susceptibility of O_2 taken up by active C at — 183° is dependent on the thickness of the adsorbed layer. A. J. M.

643. Adsorption of gases on Cu at liquid-H_2 and liquid-O_2 temperatures and at low pressures. J. Borghs and A. van Itterbeek. *Physica*, **7**, *pp.* 17–28, *Jan.*, 1940. *In English.*—Measurements have been made on the van der Waals adsorption of N_2, Ne and H_2 gas at liquid-O_2 and liquid -H_2 temperatures, on Cu. As adsorbent material electrolytic Cu of Kahlbaum, laminated to a thickness of 0·01 mm. was used. The Cu strips obtained in this way were cut into pieces of about 1 mm. × 1 mm. The measurements were made on 19·196 gm. of Cu, with a total macroscopic surface of 16·80 dm^2. The measurements on N_2 and Ne could be interpreted without any difficulty. The adsorption could be described on the lines of Polanyi's theory, and in this way it was established that $q_{N2}/q_{Ne} = \sqrt{a_{N2}/a_{Ne}}$, q_{N2} and q_{Ne} being the values of the potential functions, a_{N2} and a_{Ne} the van der Waals constants. The degree of occupation $X \times 6{\cdot}06 \times 10^{23} \times d^2/22{\cdot}41 \times 10^7$ was also computed, X being the adsorbed gas for a macroscopic surface of 1 m^2., d the diameter of the gas molecule. Even at incomplete saturation this degree exceeds the factor 7 for N_2, 11 for Ne and 14 for H_2. The adsorption for H_2 is not reversible. This is explained by the adsorption of atomic H_2 which occurs during the activation process at high temperatures. Authors.

644. Chromic oxide as an adsorbent. E. H. Harbard and A. King. *Chem. Soc., J., pp.* 19–29, *Jan.*, 1940.—The adsorption of CCl_4 on chromic oxide prepared by different methods has been measured. It is possible to correlate the adsorption capacity with the mode of formation. The isotherms are of a common type showing unimolecular adsorption, completed in the middle pressure range, and capillary condensation, which sets in at higher pressures. The greater the amount of unimolecular adsorption the lower is the pressure at which capillary condensation commences. There is a greater size distribution of the capillaries than with most other adsorbents. On the assumption that a capillary condensation mechanism is operative, a relationship has been worked out between the surface area and the mass of vapour adsorbed at a given pressure. The adsorption isotherms of a series of organic vapours and of water on chromic oxide have been compared, and the effect of dipole moment discussed. On successive adsorptions and desorptions of chloroform on chromic oxide, the shape of the isotherm changes and the amount of adsorption becomes progressively smaller until it is only a fraction of

its initial value. This is accompanied by capillary condensation setting in at increasingly higher pressures, and appears to be due to a destruction of the smaller capillaries by the adsorption of the vapour. The fine structure of the adsorption isotherm of chloroform on chromic oxide has been measured by a new type of static apparatus. The isotherm is discontinuous both in the unimolecular and in the Langmuir portion of the curve.

AUTHORS.

645. Adsorption of colouring matter by fuller's earth in decolorization of oils. B. S. KULKARNI AND S. K. K. JATKAR. *Indian Inst. of Science, J.*, **22A,** 26, *pp.* 331–340, *rec. Jan.*, 1940.—A systematic study of the problem of removal of the colouring matter in vegetable oil by various Indian fuller's earths has been made and the results have been explained in the light of the Freundlich isotherm. It is found that although the relationship between the colour removed x and the colour remaining c appears to follow exponential curves, the various requirements of the Freundlich isotherm are not fulfilled. The law does not hold in the case of decolorization (1) with higher and lower concentrations of the colouring matter, (2) higher concentrations of the active earth and (3) lower concentrations of the low grade earths. It is suggested that although some of the colouring matter is removed by purely physical adsorption, the remainder probably forms definite chemical combinations with exchangeable hydrogen of the earth. AUTHORS.

646. Adsorption of lauryl sulphonic acid in the surface of its aqueous solution, and the Gibbs theorem. J. W. MCBAIN AND L. A. WOOD. *Roy. Soc., Proc. A*, **174,** *pp.* 286–297, *Feb.* 15, 1940.—166 measurements made with the microtome and with the interferometer agree in showing that positive adsorption occurs in the surface of all dilute solutions of aqueous lauryl sulphonic acid. A similar result follows from dynamic measurements and from measurements with sodium butyl benzene sulphonate and butyl benzene sulphonic acid. No time effect is observable after the first few minutes. The surface tension of solutions of lauryl sulphonic acid changes over long periods of time extending to hours or days. Since the surface tension is at a minimum in 0·0062 N lauryl sulphonic acid, the Gibbs theorem would predict zero adsorption followed by negative adsorption, in contrast to the positive values actually found. Similar predictions would follow for all the numerous known instances of Type III curves where in extreme dilution the surface tension is lowered to a fraction of that of water, thereafter passing through a minimum or remaining constant.

AUTHORS.

647. Wetting characteristics of solid surfaces covered with adsorbed films. F. E. BARTELL AND K. E. BRISTOL. *J. Phys. Chem.*, **44,** *pp.* 86–101, *Jan.*, 1940.—Using dynamic advancing and receding contact angles, as well as static advancing contact angles, as measures of the wetting properties of solid surfaces, it has been shown that hydrophilic solids in atmospheres of high humidity, and extremely organophilic solids in atmospheres saturated with organic liquid vapours, adsorb films upon their surfaces sufficiently thick to mask the original surface properties. Less organophilic solids adsorb organic films, but these films may be stripped away by water advancing upon the surface. The values of the surface tensions of some films adsorbed upon some solids have been calculated. In order to make the calculation, one assumption had to be made: namely, that the interfacial tension between a liquid drop placed upon a film is the same as the interfacial tension between the two liquids in bulk. The calculations

indicate that the surface tensions of films of polar liquids are higher than the surface tensions of the polar liquids, but that the surface tensions of films of non-polar liquids are the same as the surface tensions of the non-polar liquids. AUTHORS.

648. Physical properties of aliphatic acid anhydrides. D. T. LEWIS. *Chem. Soc., J., pp.* 32–36, *Jan.*, 1940.—The surface tensions, densities, and viscosities of the aliphatic acid anhydrides have been determined in the range 15–50°. The parachor values reveal that the anhydrides exhibit a typical ester anomaly, the other parts of the molecules making a normal volume contribution. Certain parachor-viscosity relationships are discussed in the light of the present data. AUTHOR.

649. Electron diffraction of etched crystals. G. MENZER. *Ann. d. Physik*, **36**, 3–4, *pp.* 239–248, *Oct.*, 1939.—Experiments are described in which electron diffraction photographs of etched crystals of Cu were obtained. The photographs show more spots than would be expected on simple diffraction theory, and it is concluded that this result is due to the mosaic structure of the diffracting layers. E. E. W.

650. Growth, orientation and preparation of the surface of single crystals of copper. A. T. GWATHMEY AND A. F. BENTON. *J. Phys. Chem.*, **44**, *pp.* 35–42, *Jan.*, 1940.—Single crystals of Cu, $\frac{5}{8}$ in. in dia. and 5 in. long, were grown in a vacuum furnace using a modified form of the Bridgman method. A simple method of preparing a surface on these crystals parallel to a desired crystallographic plane is described. A very bright and smooth finish may be produced by using the electrolytic polishing method. This has the decided advantage of removing any strained or amorphous layers on the surface simultaneously with the polishing. The specimens so prepared may be used for studying any of the surface phenomena of single crystals of Cu. AUTHORS.

651. Electrocapillary curves for extremely dilute amalgams. T. ERDEY-GRÚZ AND O. BAJOR. *Zeits. f. Elektrochem.*, **45**, *pp.* 707–712, *Sept.*, 1939.—The electrocapillary curves for very dilute amalgams of Zn, Cd, Tl, Pb, Bi and Cu were determined by the drop electrode method. When the concentrations were smaller than 10^{-5} gm.-atom/l. the electrocapillary curves coincided with that of pure Hg, or showed only the slightest deviation from it. The displacement of the potential at the maximum of the electrocapillary curve in the critical concentration range in the same solution, is greater the more noble the metal in the amalgam. The maximum of the electrocapillary curve depends not only on the nature of the metal in the amalgam, but is influenced by the ions in the solution. F. J. B.

652. Interfacial curvature and solubility. R. S. BRADLEY. *Faraday Soc., Trans.*, **36**, *pp.* 392–394, *Feb.*, 1940.—The change in solubility when curvature occurs at the interface between two liquids is considered in the light of the change in energy due to molecular interaction, without referring explicitly to the surface pressure due to curvature. Very small droplets, to which Kelvin's equation is of doubtful applicability, come within the scope of the method, which also applies to the condensation of vapours on nucleating particles or in capillary systems. P. H. B.

See also Abstracts 786, 819, 825, 853, and

206B. Principle of mechanical similarity applied to lubricating films. A. A. Capocaccia.

234B. Structure and properties of bright nickel deposits. A. W. Hothersall and G. E. Gardam.

257B. Film-forming plastics. F. W. Reinhart and G. M. Kline.

TIME.

See Abstract 637.

VISCOSITY AND FRICTION.

653. Viscosity of mixtures of solutions of strong electrolytes with special reference to the Onsager-Fuoss theory. E. Asmus. *Ann. d. Physik*, **36**, 2, *pp.* 166–182, *Sept.*, 1939.—The Onsager-Fuoss theory [see Abstract 741 (1933)] results in a formula for the additional viscosity $\Delta\gamma$ caused by the mutual electrostatic forces of the ions. This is modified to an expression $\gamma/\gamma_0 = 1 + a\sqrt{\Gamma}$ for the relative viscosity γ/γ_0 as function of the total ionic concentration Γ, γ_0 referring to the case $\Gamma = 0$. The coefficients, a, are calculated for aqueous solutions of $CuSO_4$ and KCl and also $CuSO_4$ and H_2SO_4. Experiments show $\gamma/\gamma_0 = 1 + a\sqrt{\Gamma} + b\Gamma$ to be more adequate. Empirical values of a are in agreement with those calculated. Coefficient b does not seem to be of additive character. Use is made of matrix calculus. H. O. S.

654. Influence of Brownian movement on the viscosity of solutions. R. Simha. *J. Phys. Chem.*, **44**, *pp.* 25–34, *Jan.*, 1940.—The calculation of the viscosity of dilute solutions of non-spherical particles as a function of their dimensions and of the concentration is discussed. Three different cases must be distinguished according to the magnitude of the factor κ/D (D = rotational diffusion constant of the particles assumed as spheroids and κ = velocity gradient of the flow in the viscosimeter). κ/D infinite characterizes the purely hydrodynamic case, treated by Jeffery for the case of a Couette streaming. Finite κ/D means that the irregular thermal motion is superimposed upon the orientation tendency of the shear. This problem and its difficulties, due to the incompleteness of the hydrodynamic solution, are not further discussed, but the third case of complete Brownian movement ($\kappa/D \to 0$) is considered. Here the macroscopic flow is no longer able to bring about a regular rotational motion of the ellipsoids against the thermal motion, which, on the average effects an isotropic distribution of the particle axes in the fluid. The specific viscosity $(\mu - \mu_0)/\mu_0$ is calculated. Possible extensions of these results to other types of flow, especially the streaming in a capillary tube, are discussed. Theoretical considerations as well as experimental results show improvements in the theory and further experiments to be necessary. Author.

655. Viscosity of liquid hydrogen. H. E. Johns. *Canad. J. of Research, Sect. A*, **17**, *pp.* 221–226, *Dec.*, 1939.—The viscosity of liquid hydrogen has been measured by observing its flow through a variety of capillary tubes. The resulting viscosities are about 10% higher than those obtained by Keesom and Macwood using an oscillating disc. [See Abstract 3570 (1938).] Author.

656. Viscosity of hydrogen vapour. W. H. Keesom and P. H. Keesom. *K. Onnes Lab., Leiden, Comm. No.* 257*c*. *Physica*, **7**, *pp.* 29–32, *Jan.*, 1940. *In English.*—New measurements of the viscosity of the saturated vapour of liquid H_2 from 14 to 20·5°K. are reported. The viscosity can be represented by the formula $\eta = (0{\cdot}584T - 0{\cdot}55) \times 10^{-6}$ (poise). Authors.

***657. Influence of temperature and specific volume on viscosity of liquids. Part III.** W. R. van Wijk, J. H. van der Veen, H. C. Brinkman and W. A. Seeder. *Physica*, **7**, *pp.* 45–56, *Jan.*, 1940. *In English.*—

An apparatus for the measurement of viscosity of liquids under pressures up to 1 500 atm. and temperatures ranging from 0°C. up to 150°C. is described. The viscosity of propane, tetramethylmethane, carbon tetrachloride and octadecylalcohol was measured in this apparatus as a function of temperature and specific volume and the results discussed in connection with the structure of these liquids. It is further pointed out that tetramethylmethane might serve as a standard liquid for high-pressure measurements. [For Part II see Abstract 1021 (1939).]

658. Pressure and temperature effects on viscosity of liquids. D. Frisch, H. Eyring and J. F. Kincaid. *J. of Applied Physics*, **11**, *pp.* 75–80, *Jan.*, 1940.—The free energy of activation for viscous flow is related to an entropy and energy of activation by the same equations as any equilibrium. This, for the theory of viscosity is perfectly general and independent of the mechanism. The rolling over each other of pairs of molecules lying in adjoining layers is the mechanism which appears to be the most probable, and the equations for this bimolecular flow process are developed here. At low pressures the heat of activation for viscous flow is about one-third the energy of vaporization, but as the pressure is raised, it increases rapidly because of the work term, PV/n'. Here P is the external pressure, C is molal volume and V/n' is the extra volume required before the flow process can take place. Calculations made for *n*-pentane, ether, benzene, iso-pentane, water, and mercury over as extended a temperature and pressure range as the data permit are found to agree satisfactorily with the experimental viscosity. The results are interpreted in terms of the liquid structure and the mechanism of viscous flow. The results of applying our theory to the liquids for which the necessary data are available show that the effect of pressure on viscosity can be calculated *a priori*, with thermodynamic data only, with reasonable success.

Authors.

***659. Rotary viscometer.** A. H. Nissan, L. V. W. Clark and A. W. Nash. *Journ. Sci. Instruments*, **17**, *pp.* 33–38, *Feb.*, 1940.—A rotary viscometer, of the Couette type, has been developed with an overall accuracy of 1% in the range of viscosities exceeding 10 poises, using N.P.L. viscometry as a standard check method. The chief sources of error in such apparatus are end effects, eccentricity of cylinders relative to each other, variation of speed and variation of temperature during the measurements. These have been either eliminated or reduced to an acceptable minimum. The paper illustrates these points, describes the apparatus and its novel method of eliminating end effects by means of a sharp-edged weir on the rotating cylinder and gives typical results on viscosity measurement.

Authors.

See also Abstracts 648, 825.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***660. Clock-controlled gravity drive for small telescopes.** H. B. Brydon. *Roy. Astron. Soc. Canada, J.*, **33**, *pp.* 379-383, *Nov.*, 1939.—In the Sellars form of drive, the clock is exposed to large and uncertain variations, since

it acts directly upon the driving weight suspension. The author uses a second worm, so as to avoid the speed-reducing gear train by introducing the winding spindle of a " dollar alarm " clock (P) by which the rotation of a worm (M) and consequently the rotation of the wheel (L) and of the drum and polar axis are controlled by the (constant) speed of the winding spindle of the clock. This mechanism acts as slave under control of the master (P). Two illustrations are given, and 9 suggestions for putting the new drive into service, including the prescription for " an excellent clock oil". A. S. D. M.

See also Abstracts 675, 686.

COMETS AND METEORS.

661. Radioactivity of K and the relative age of elements in meteorites. H. Suess. *Naturwiss.*, **27**, *pp.* 702–704, *Oct.* 20, 1939.—The activity of the K, obtained from samples of 3 different stony meteorites found in different parts of the world, is measured by means of a Geiger-Müller counter. Within the limit of experimental error the activity is found to be the same as that of K found on the earth. The bearing of this result on the origin of the solar system is discussed. W. E. D.

See also Abstract 603.

COSMOGONY.

662. Cosmological theory. P. Jordan. *Ann. d. Physik*, **36**, 1, *pp.* 64–70, *Sept.*, 1939.—The author's conceptions given in this paper are based essentially on Dirac's principle that the large dimensionless numbers of terrestrial and cosmic physics may be explained in terms of the age of the universe. Logical development of this principle leads to the conclusion that a steady increase of the amount of matter in the universe is occurring by the creation of stars and spiral nebulae, whose negative gravitational energy balances the mass energy produced. A. Hu.

663. Wave-mechanics and stellar theory. Part III. H. Jehle. *Zeits. f. Astrophysik*, **19**, 2, *pp.* 132–135, 1939.—In continuation of his previous work [see Abstract 2395 (1939)], the author attempts to reconcile the apparent contradiction between the general wave-equation, linear in ψ, and the Boltzmann equation of stellar statistics, which is non-linear in f. A. Hu.

664. Fundamental problems of cosmogony and Newton's law. G. Armellini. *Accad. Lincei, Atti*, **29**, *pp.* 649–655, *June* 17, 1939.—The author has shown [see Abstract 1027 (1939)] that the peculiarities of the solar planetary system can be explained if Newton's law is modified by a small term which depends on the velocity, thus: $F = -(f m m^1/r^2)(1 + \epsilon\, dr/dt)$, where ϵ is a positive constant called the cosmogonal coefficient. In this paper the author investigates the question whether conditions are compatible that ϵ is so small as not to produce noticeable perturbations in the planetary motions and that it is sufficiently big to make the planetary orbits quasi-circular and less inclined to the solar equator in a time interval not greater than the age of the solar system. It is shown that, if ϵ is assumed to be 4×10^{-14} in c.g.s. units, the secular variation of eccentricity of the terrestrial orbit is: $\Delta E = -0{\cdot}000\,000\,6$ and the secular variation of the inclination of the terrestrial orbit $\Delta I = -0{\cdot}000\,05''$. Both quantities are too small to be observed so that the conditions are fulfilled. In the second part of the paper the

author derives formulae which connect the mean radius of a planetary orbit with the cosmogonal coefficient, the constants of the solar system and the time. L. K.

See also Abstracts 640, 641.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

665. Advance of node and of perihelion of a planet under action of circular annulus. J. Chazy. *Bull. Astronomique*, **11**, 7, *pp.* 327–348, 1938.—The movements of a planet in a gravitational field with axial symmetry due to a circular annulus and a central body is studied. It is proved that the osculating eccentricity is equal to the ratio of the perturbing force due to the annulus to that due to the central attracting body. The node is retarded at each revolution and its movement is constantly retrograde. Formulae for the period of the draconian revolution and for the advance of the node, as well as for the period of the anomalous revolution and of the advance of perihelion are given. The formulae are accurate to the order of the eccentricity and of the square of the inclination of the orbit. G. C. McV.

NEBULÆ.

666. Grey clouds in the field β, 0, 103 Tauri. K. Graff. *Akad. Wiss. Wien, Ber.*, **148**, 2a, 1–2, *pp.* 59–65, 1939.—The observation from Mallorca in 1934 of faint grey nebulae in the region between β, 0 and 103 Tau. is described. The contours of these grey clouds are compared with photographs of the region and found to coincide with the regions of least photographic stellar density; this coincidence is clearly revealed by a chart showing the distribution of B0 to B8 stars in the region. The possible reasons why a region which appears visually as a faintly luminous nebula against a darker background should appear by its photographic unresponsiveness as a dark absorbing or starless region are discussed. Reference is made to Milky Way photographs by Ross and Calvert on which some indications of faint nebular smears have been revealed. J. E. K.

667. Spectra and chemical composition of gaseous nebulae, NGC 6572, 7027, 7662. I. S. Bowen and A. B. Wyse. *Lick Observat., Bull., No.* 495, *pp.* 1–16, 1939.—An investigation as to whether the chemical composition of gaseous nebulae differs materially from that of stars. The three very bright planetary nebulae, NGC, 6572, 7027, 7662, were observed with low-dispersion spectrograph attached to the 36-in. refractor (a table is given of the observed nebular lines). The methods, wavelengths, intensities and identifications are described and discussed. For the elements observed, a table is given of the strongest lines from H to Fe; 3 mechanisms of excitation are discussed, and their relative abundances in 7027, with a table. In general this method gives information as to the abundance of only a very few stages of ionisation of any one element. In this table it is possible to set upper limits for the abundance. [See Abstract 3986 (1938).] A. S. D. M.

668. Occurrence of λ3727 (O II) in extragalactic nebulae. N. U. Mayall. *Lick Observat., Bull., No.* 497, *pp.* 33–39, 1939.—The author gives 4 tables and 2 plates. The first table summarizes the possible dependence of λ3727 upon nebular types. In elliptics it is rare, two cases are alone found. In normal spirals it occurs more often in late and intermediate spirals than in early; in barred, 1 in 3 for 12 cases; in irregulars, perhaps 1 in 3. There may be a loose relationship between (O II) and the

presence of other bright lines; no obvious link is found between its intensity and the absorption band width, but some with absorption visibility; it is closely linked to the relative strength of the near u.v. continuous spectrum. He discusses the reason for its being found more often than other forbidden lines, and whether it originates from stars of high luminosity involved in the nebula or from interstellar space. [See Abstract 4401 (1938).] A. S. D. M.

PLANETS.

669. Photographic photometry of Jupiter's disc. J. Plaetschke. *Zeits. f. Astrophysik*, **19**, 2, *pp.* 69–115, 1939.—Photographic exposures on Jupiter through 5 colour filters enable the author to derive the luminosity distribution along the bright and dark equatorial belts in 5 spectral regions, and to compare his results with those of other authors in other regions. The limb-darkening is bigger at longer wavelengths owing to the presence of absorption bands in the atmospheric spectrum; and it is less in the dark belts than in the bright. The contrast between the belts decreases with increasing wavelength, and, as a result of the different limb-darkenings, varies across the disc. The absorption coefficients appear to be functions of epoch, i.e. the transparency of the atmosphere varies from time to time, which is not surprising, considering the variable appearance of the disc. A. Hu.

670. Photometric phase curve of the planet Mercury. K. Graff. *Akad. Wiss. Wien, Ber.*, **148**, 2a, 1–2, *pp.* 41–48, 1939.—The brightness-phase curve of Mercury is derived from 140 photometric observations made at Mallorca in Dec. 1930, Jan., Feb., Sept. and Oct., 1931, and Jan. and Feb., 1935. The brightness H is expressible in terms of the phase I by the linear formula $H = -0^m{\cdot}968 + 0^m{\cdot}034\,48\,(\phi - 50°)$. This formula is almost identical with one deduced by J. Schmidt and closely similar to that of G. Müller; the formula given by J. Hopmann in 1922 which differs from these by $0^m{\cdot}4$ is almost certainly in error. J. E. K.

671. Light variation of Saturn satellites Titan and Japetus in 1922. K. Graff. *Akad. Wiss. Wien, Ber.*, **148**, 2a, 1–2, *pp.* 49–57, 1939.—Measurements made between Feb. and June, 1922, of the brightness of Saturn's moons Titan and Japetus are communicated. The brightness of Titan is constant; the mean value $8^m{\cdot}34$ agrees well with the value $8^m{\cdot}30$ measured by H. N. Russell. The brightness of Japetus varies in an almost cycloidal manner, there is a flat maximum and a sharp minimum, the extreme values being $10^m{\cdot}2$ and $12^m{\cdot}2$ respectively. The minimum occurs 15° or $3\frac{1}{2}$ days before the easterly elongation and the maximum 7° or $1\frac{1}{2}$ days after the westerly elongation. The maximum to minimum brightness ratio is 6·3 : 1. The observations are in good general agreement with a curve deduced on the hypothesis that Japetus consists of a bright hemisphere and a $6\frac{1}{2}$ times darker one, and that in its orbital motion the same side is always turned towards Saturn. J. E. K.

See also Abstract 665.

STARS.

672. Progressive stellar brightness changes. E. Zinner. *Zeits. f. Astrophysik*, **19**, 1, *pp.* 45–49, 1939.—Gunther's measurements of brightness of light stars are applied to demonstrate the progressive changes of brightness of stars. The difficulties of proving the existence and magni-

tude of such changes of brightness with data obtained over a comparatively short period of time are indicated. Lundmark's objections to the progressive change of brightness of δ Cephei stars are discussed. J. E. K.

673. Trumpler's stars. J. Tuominen. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 86–93, *Dec.*, 1939.—It is shown that scattering by free electrons is a much more important source of opacity than photoelectric absorption in the interior of Trumpler's stars. When account is taken of this fact, the discrepancy between observed and computed magnitudes is reduced from the average value 4·2, which follows from the calculations of Beer and Chandrasekhar, to the average value 1·8. It appears that the discrepancy is larger for later type stars, as it vanishes for about O6–O7 stars. Possibilities for explaining the discrepancy are discussed. Author.

674. Stellar parallaxes determined photographically at the Royal Observatory, Cape of Good Hope (Eleventh list). *Roy. Astron. Soc., M.N.*, **100,** *pp.* 128–134, *Dec.*, 1939.—The form of publication is similar to that of previous lists [see Abstract 587 (1939)].

***675. Magnitudes and colours of stars of large proper motion.** C. K. Seyfert. *McDonald Observat., Univ. of Texas, Contrib. No.* 16. *Astrophys. J.*, **91,** *pp.* 117–125, *Jan.*, 1940.—Photographic and photovisual magnitudes on the International System have been determined for 144 stars, mostly of proper motion larger than 0″·3 per year, from focal plates taken with two 3-in. Ross cameras. For 91 additional proper-motion stars photovisual magnitudes have been determined from extra-focal plates taken with a 5·7-in. camera with u.v. optics. A simplified photometer built for the purpose of measuring these latter plates is described. Author.

676. Variable spectrum of α^2 Canum Venaticorum. W. S. Tai. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 94–127, *Dec.*, 1939.—Along with EuII, GdII and DyII are found to be present in the atmosphere of α^2 CVn. Lines due to these two elements are found to behave in the same manner as EuII lines. CeII, TbII and SaII are probably present. For the other rare-earth elements, the data available are not sufficient either to establish their presence or to eliminate them from further consideration. The light curve is determined with a photoelectric photometer. The apparent magnitude of the star is found to vary in a period of about 5·47 days, the range of variation being only $0^m{\cdot}035$. This confirms roughly earlier observations by Guthnick and Prager. The colour temperature is found to vary during each light cycle, minimum occurring near light maximum and vice versa. The evidence is, however, not conclusive. The temperature change corresponds to a change of spectral type from A0 to B5, but the spectrum does not reveal such a big change. HeI is probably absent all through the cycle, so are other high excitation lines, such as SII, OII and NII. Two groups of variable lines are present in the spectrum. One group (A) strengthens at light maximum and colour temperature minimum, whereas the other group (B) strengthens at light minimum and colour temperature maximum. To Group A belong EuII, DyII, GdII, CeII lines, K line of CaII, the majority of TiII lines, and probably SrII, SaII, YII and ZrII. To Group B belong the H lines, SiII 4 128 and 4 131, MgII 4 481, as well as most of the FeII and CrII lines. The Group B lines have in general higher I.P. and higher E.P. than Group A lines. If the temperature range 9 000° to 10 000° (corresponding to spectral type A3 to A0) and a two-fold increase of electron pressure (10^{-4} atm. at 9 000° and 2×10^{-4} atm. at 10 000°) be adopted, the spectral change in terms of thermal

ionization and excitation can then be explained. Several Group B lines which were formerly attributed to Tb are now shown to be due to something else. The lack of uniformity in the behaviour of TbII lines throws doubt on its presence. Among the neutral metallic lines, only those strong lines due to MgI, FeI and CrI are definitely present. They are mostly faint and quite constant. The Balmer jump in α^2CVn was observed by Barbier, Chalonge and their colleagues to be smaller than in other main-sequence A0 stars. This may indicate smaller H content in the star, and may have something to do with the unusual abundance of the rare-earth elements and the behaviour of the spectral lines. AUTHOR.

677. Spectrum of 25 Orionis, 1933–1939. H. W. DODSON. *Astrophys. J.*, **91,** *pp* 126–128, *Jan.*, 1940.—During 1933–1938 the H lines showed equal emission components and no variations in velocity. Throughout this interval the emission lines steadily increased in width. In 1938–1939 the violet component became stronger than the red, velocities increased, and emission widths diminished. [See Abstract 4584 (1936).] AUTHOR.

678. Composite spectrum of T Cor B. P. WELLMANN. *Zeits. f. Astrophysik,* **19,** 1, *pp.* 16–20, 1939.—Quantitative measurements on spectrograms of T Cor B show that the radiation emitted [see Abstract 1047 (1939)] corresponds to a mixture of light from an early M-type giant ($T = 3\,000°$) and a hot star ($T = 16\,000°$) of approximately equal photographic luminosity. A. HU.

679. Chemical composition and dynamical stability of stars. Part II. L. BIERMANN AND T. G. COWLING. *Zeits. f. Astrophysik,* **19, 1,** *pp.* 1–10, 1939.—In continuation of a previous paper [see Abstract 3591 (1938)], the authors investigate how the stability of a star is affected by its chemical constitution and its radius R. The criterion used is the sign of $\partial E/\partial R$, where E is the total energy; with the help of this criterion the stellar models under investigation are compared with neighbouring synthesized configurations. Stability demands a positive sign. It is shown that for radii more than a certain limiting value (about 30 to 100 times that of the sun, depending on the mass), dynamical considerations of stability render necessary a limiting H content. Consideration of the ratio of the specific heats leads to a similar conclusion. Certain cosmological consequences of this result are discussed. A. HU.

680. Evolution of the stars. F. HOYLE AND R. A. LYTTLETON. *Nature,* **144,** *pp.* 1019–1020, *Dec.* 16, 1939.—The authors criticise Gamow's conclusion [see Abstract 4503 (1939)] that the problems of stellar evolution have been practically solved by recent developments in nuclear physics; and point out that certain results of the theory are at least as embarrassing as the questions it solves. Such puzzling conclusions as that no synthesis of heavy elements can occur in the stars, and that red giant stars are all of recent formation, are direct deductions from the theory, and are difficult to understand. The authors believe that over-estimation of the importance of nuclear processes in stellar evolution is apt to lead to a distorted view of the problem, in which too little regard is paid to dynamical features related to the previous history of the stars. Such questions as the formation of binary and multiple systems, and the observed approximation to equipartition of energy amongst the stars should be at the basis of any satisfactory theory of stellar evolution. A. HU.

681. Proton-deuteron transformation as a source of energy in dense stars. W. A. WILDHACK. *Phys. Rev.*, **57,** *pp.* 81–86, *Jan.* 15, 1940.—The rates of energy evolution due to the transformation to He, starting with the

reaction $H + H = D + e^+$, in hydrogen at densities of 10^4 to 10^8 gm./cm^3., were calculated on the basis of complete degeneracy, and the assumption of a crystal-like spacing of the protons. The results indicate that any considerable amount of hydrogen in white dwarf stars would lead to much higher luminosities than those observed. Thus the low effective molecular weight (1·5) as calculated for some of these stars from the accepted white dwarf model, cannot be due to a high content of hydrogen. It might be explained as due to very large content ($\sim 100\%$) of He^3 but it is very difficult to see how such large amounts of this isotope could be present in these stars. It appears that the paradox can be removed only by revision of the observational data concerning the white dwarf radii. AUTHOR.

682. Scorpio-Centaurus cluster (the Southern Stream). W. M. SMART. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 60–85, *Dec.*, 1939.—For a quarter of a century a number of B-type stars (132, according to Plaskett and Pearce) lying between galactic longitudes 210° and 330° have been believed to form a moving cluster, known as the Scorpio-Centaurus Cluster or the Southern Stream, owing to the convergence of their proper motions. As a basis of investigation Rasmuson's list of 160 stars is used for deriving the position of the convergent point whose equatorial co-ordinates are found to be (91°, – 37°), in close proximity to the solar antapex. On the assumption that the stars form a moving cluster the " stream-velocity " is then derived by means of the observed total proper motions and spectroscopic parallaxes; this is found to be 18·8 km./sec. The parallax and absolute magnitude of each star are then calculated ; the application of the absolute magnitude criterion is mostly inconclusive as to the constitution of the " cluster". With the value, 18·8 km./sec., of the " stream-velocity " the " calculated " radial velocity of each star is found and compared with the observed radial velocity. The difference should, theoretically, be the K term—the stars form a moving cluster—which is treated in two ways (*a*) as a constant, and (*b*) as affected by differential galactic rotation. The result of the ensuing discussion is held to be conclusive against the conception that the stars concerned form a moving cluster ; the " stream-velocity " is identified with the solar velocity and the " convergent point " with the solar antapex. The mean residual speed of the " cluster stars " is found to be of the same order of magnitude as that found in general investigations, and the K term is also found to be normal in magnitude. AUTHOR.

683. Spatial distribution of stars in the Southern Milky Way and the density decrease perpendicular to the galactic plane. F. BECKER. *Zeits. f. Astrophysik*, **19,** 1, *pp.* 50–58, 1939.—The spatial distribution in the galactic plane and the density gradient perpendicular to the plane of the Milky Way is investigated for stars of spectral classes A and F in the Kapteyn fields of the southern sky. The Carina star cluster is shown again to be an important element of structure of the region near the sun. At a distance of 300 parsecs south of the galactic plane the spatial density of A stars is about 1/20th and that of F stars about 1/5th of the mean density in the galactic plane. J. E. K.

684. Determination of elements of eclipsing binaries. A. B. WYSE AND G. E. KRON. *Lick Observat., Bull., No.* 496, *pp.* 17–31, 1939.—In Part I are derived formulae in which the method of least squares is applied to the determination of the elements of eclipsing binaries, without assuming for the disc of the primary component either uniform illumination or complete darkening at the limb. Recent increases in the accuracy of photo-electric observations make it possible to include the limb-darkening

coefficient as one of the unknowns in the least squares solution. The method allows simultaneous treatment of the 2 minima of the light curve, and lends itself readily to the simultaneous analysis of 2 light-curves at different wavelengths. For partially-eclipsing systems it may in time become possible to estimate the coefficients of limb darkening from other known properties of the stars concerned; the method is well adapted to the subsequent computations in such cases. In Part II the authors give tables to facilitate the calculation of the differential coefficients derived in Part I, and apply the whole method to calculating the elements of YZ Cass. A. Hu.

685. Determination of orbital elements of eccentric eclipsing binaries. T. E. Sterne. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 36–40, *Jan.*, 1940.—Simple and closely approximate formulae are given, valid for large values of the orbital eccentricity e, for deriving preliminary values of the true orbital elements of an eclipsing binary star from the "circular" elements of its eclipses. The formulae are equivalent to Russell's [see Abstract 1664 (1912)], designed for small values of e, when e is small; they are more accurate than Russell's when e is large. Author.

See also Abstracts 663, 666, 692.

SUN.

***686. New images of solar chromosphere.** L. d'Azambuja and (Mme) d'Azambuja. *Bull. Astronomique*, **11**, 7, *pp.* 349–359, 1938.—The only permanent He line (10 830 Å) recognized in the Fraunhofer spectrum is observed both in the upper chromosphere and in prominences. Details fall into (1) those in the photosphere, where radiation is most intense, the faculous region, and a network of small clouds; and (2) those where these seem to bear no relation to the photospheric details, of which the most important are the dark flocculi. The authors describe the Meudon Observatory spectroheliograph, the plates and methods adopted, etc. They find that He 10 830 is in practice visible only at points on the disc where images of ionized Ca and of H show faculous regions, or dark absorption markings. A. S. D. M.

687. Polarization of solar corona. Z. Sekera. *Zeits. f. Astrophysik*, **19**, 1, *pp.* 11–15, 1939.—The author derives expressions for the corrections to be applied to the observations of the coronal polarization to allow for the polarization of the general light of the sky near the sun. A. Hu.

688. Nature of faculae on the solar disc. P. ten Bruggencate. *Zeits. f. Astrophysik*, **19**, 1, *pp.* 59–67, 1939.—The granular structure of the solar disc near faculae is studied by means of photographs in white light. The notion of a "facular" granule is introduced. This type of granulation differs from the normal photospheric granulation in that its half-life-period is about 1 hr. compared with the 2 min. of the photospheric granule. The facular granule also makes a greater contrast with its surroundings than the photospheric, but the size of both types of granule is about the same, viz. :—1″ to 2″. G. C. McV.

689. Present state of solar activity and associated phenomena. H. T. Stetson. *Science*, **90**, *pp.* 482–484, *Nov.* 24, 1939.—The author notes that (1) the maximum of 1937 was the highest since 1870, (2) the interval between the two maxima, 1928–1937, was 9 years, not 11·2; (3) this corroborates Stewart and Panofsky's prediction [see Abstract 183 (1939)]; (4) there exists a marked tendency for brighter aurorae to occur on the

average about a year after sunspot maximum ; (5) if these are corpuscular they should be most conspicuous when large spots are central or near the sun-earth line, involving a connection with decreasing solar latitudes, even though the number of sunspots have declined ; (6) even on the hypothesis that the bright eruptions are flares of u.v. radiation [see following Abstract] this should occur, and gives a possible qualitative explanation for the delay after sunspot maximum, of auroral frequency. A. S. D. M.

690. Sunspots, bright eruptions and magnetic storms. H. W. Newton. *Observatory*, **62**, *pp.* 318–326, *Dec.*, 1939. –Four series of facts indicate the relationship between solar outbursts and magnetic storms, and suggest that these are corpuscular streams taking about a day to travel from sun to earth. The author illustrates by tables and diagrams the association of spots (according to size) and magnetic storms. Recurrence of lesser storms at about 27-day intervals (the solar rotation) points to their solar origin. He discusses the relation of H and K and H_α to the "bright patches" near sunspots ; also of bright eruptions (for intensities 3 and 2) with magnetic storms (according to size) and gives diagrams. He suggests that a major bright eruption is a critical phenomenon in the occurrence of great magnetic storms ; also a relationship between bright eruptions and simultaneous ionospheric disturbances, causing sudden fade-outs. He gives 4 characteristics, which harmonize with the idea that the solar flares of u.v. light may have a common point of origin with the corpuscular streams. [See preceding Abstract.] A. S. D. M

691. Agincourt magnetic data 1899–1937 and the sunspot cycle. W. E. W. Jackson. *Roy. Astron. Soc. Canada, J.*, **33**, *pp.* 401–414, *Dec.*, 1939.—Photographic records of the variations in declination, D, and horizontal force, F, have been obtained at the Agincourt Magnetic Observatory over three sunspot cycles and of vertical force, V, over two. Tables of the mean monthly and annual values of D, H and V, as well as tables of mean monthly diurnal ranges of these quantities are given. It is shown by a least-squares calculation that D, H and V can all be expressed as linear functions of the Wolfer sunspot number. It is concluded that there is some force at work in the sun which manifests itself in two distinctly different phenomena : sunspots on the one hand and variations in the earth's magnetic field, on the other. G. C. McV.

692. Corrected theory of aberration. V. Nobile. *Accad. Lincei, Atti*, **29**, *pp.* 656–664, *June* 17, 1939.—The author discusses the results of a previous paper on the influence of a plane circular motion of the sun round the gravity centre of the planetary system on the aberration. He shows that the effect of the planetary perturbations on the correction of the aberration is negligible, and that a lunar effect is much smaller than the effect of the solar motion. He concludes that a preliminary numerical computation based on our actual knowledge of the planetary system gives no conclusive results on account of the incompleteness of these data. It seems therefore necessary to institute new special observations for the numerical determination of this additional term in the theory of aberration. [See Abstract 1031 (1939).] L. K.

693. Law of solar rotation. R. E. De Lury. *Roy. Astron. Soc. Canada, J.*, **33**, *pp.* 345–378, *Nov.*, 1939.—The author discusses factors which determine the accuracy of different methods (spectroscopic and by solar markings) of determining the rate of solar rotation and its variation with latitude. The formulae adopted by different observers to express the relation between angular velocity and latitude vary considerably.

The author's new formulation of this law, however, harmonizes results whose actual similarity had been disguised in approximate representations by conventional formulae. Failure of the new formula to represent closely any series of values of the solar rotation can be satisfactorily explained either by certain experimental errors, which are fully discussed, or by systematic variations in rotational velocity dependent on the age of sunspots and groups. It is concluded that sunspots and the spectroscopically observed solar surface rotate identically; faculae and flocculi move about 1% more rapidly; and prominences still more speedily. A. Hu.

694. Green corona line 5303 A. M. Waldmeier. *Zeits. f. Astrophysik*, **19**, 1, *pp.* 21–44, 1939.—A description is given of the apparatus and procedure used in a spectroscopic investigation of the corona under non-eclipse conditions from Arosa (1900 m.) in the winter 1938–39. The maximum of 5303 Å coincides with the sunspot zones and not with protuberance zones. It extends far beyond the latter and disappears altogether in polar zones. The axis of symmetry of the isophot contours concides with the axis of rotation and is thus not oriented with regard to the magnetic axis. The ellipticity of the isophot contours of 5303 Å is greater than that of the contours of the total radiation. In some regions of very intense line emission 5303 Å is about 3 Å wide and exhibits a 0·4 Å wide dark self-absorption line in its centre. These regions of intense emission occur only in sunspot zones but are not usually associated with spots but with parts which are photospherically and chromospherically unperturbed and show great stability. Convincing evidence of a direct connection between these regions and terrestrial magnetic disturbances is obtained. The regions of increased line emission from the corona are the sources of solar corpuscular radiation. J. E. K.

ZODIACAL LIGHT AND GEGENSCHEIN.

695. Spectrum of the night sky and zodiacal light. C. Hoffmeister. *Zeits. f. Astrophysik*, **19**, 2, *pp.* 116–131, 1939.—From plates taken at Windhuk, S.W. Africa, wavelengths are derived, with a mean error of about 6 Å, for 19 emission lines in the spectrum of the night sky. Their intensities seem to vary with time, though the brighter belts of the sky give the same spectrum as the normal parts. Details are also given of the spectra of the zodiacal light and gegenschein; in both cases the emission lines are weakened and a Fraunhofer continuum is superposed on the ordinary night-sky spectrum. The emission line at 3910 Å is, however, strengthened in the zodiacal light: this is probably the auroral line at 3914 Å and no doubt originates in the upper atmosphere. In the gegenschein all emission lines between 3400 Å and 5600 Å are weakened, and a solar spectrum is superposed. A. Hu.

GEOPHYSICS.

HYDROSPHERE, PHYSICS OF THE.

696. "Tunami" or destructive sea waves excited by a travelling cyclone. K. Terada. *Imp. Marine Obs. Kobe, Japan, Mem.*, **7**, 2, *pp.* 209–230, *July*, 1939.—Mathematical expressions are developed for the

general theory of "tunami" and applied to 3 special cases for a rectangular lake whose length is $\gtrless$ the width of the shock. The results are then applied to provide a partial explanation of the "Tunami" at Oosaki and its surroundings during the typhoon of 21/9/34. It is concluded that (1) the elevation is a maximum when the velocity of the typhoon coincides with the value $\sqrt{gh}$ where h is the depth of the lake; (2) the time lag of occurrence of maximum elevation after the arrival of the typhoon centre generally increases as the velocity of the typhoon increases, and (3) when a typhoon crosses a bay, the maximum elevation at the place where the typhoon ceases to cross the bay is generally greater than at the place where it begins to cross the bay. R. S. R.

LAND, PHYSICS OF THE.

697. Photometric sorting of sands. L. H. Berthois and P. M. Duffieux. *Comptes Rendus*, **209**, *pp.* 889–891, *Dec.* 11, 1939.—The grains of sand are very thinly mounted on a microscope slide, so that practically each grain is separate. The slide is illuminated uniformly from above with an arrangement below to measure photoelectrically the flux of light passing through the illuminated area, S, of the slide. The flux of light passing through this area being ϕ_0 when no grain intervenes, and ϕ when a grain of area s does intervene, then $s = S\ (\Phi_0 - \Phi)/\Phi_0$. A suitable arrangement for illuminating the slide and measuring the flux is described in some detail. C. A. S.

698. Electrical method for identification of sands. W. F. Tanner. *Am. J. Sci.*, **238**, *pp.* 42–46, *Jan.*, 1940.—Sorting and angularity, as clues to the method of deposition of sands, are discussed. A method of measuring angularity is described, and a means of graphic representation is given. Formulae, for the extension of the various curves, are listed. Author.

699. Radioactivity in the Island of Ischia. O. Scarpa. *Ricerca Scientifica*, **10**, *pp.* 988–991, *Nov.*, 1939.—An account is given of measurements of the radioactivity of thermal springs and escaping gases in the Island of Ischia in the Bay of Naples, taken with a view to the possibility of exploring for strong radioactive sources. E. E. W.

***700. Earth-pressure cell.** I. F. Morrison and W. E. Cornish. *Canad. J. of Research, Sect. A*, **17**, *pp.* 216–220, *Nov.*, 1939.—The vibrating wire method for measuring strains is used to determine the pressure applied to an earth pressure cell. The construction of the cell, the principle on which it acts, and electrical circuits are described. Authors.

METEOROLOGY.

701. Meteorological history of New England hurricane of Sept. 21, 1938. C. H. Pierce. *Monthly Weather Rev.*, **67**, *pp.* 237–285, *Aug.*, 1939.—The details of the structure and the motion of the storm as shown from surface and upper-air observations within or near it form the subject matter of the paper. A large number of isobaric and isentropic charts indicate the path of the storm as it moved from lat. 23°N. long. 53°W. on Sept. 16, first in a westerly direction then northwards along the east American coast until in lat. 41°N. long. 73°W. the centre passed from the sea to the land at 3 p.m. on Sept. 21. Thereafter it continued to move

rapidly northwards and began to fill up. The clear calm area experienced in the " eye " of the hurricane was observed in many places, and reports indicate that its width was at least 43 miles. A large number of thermograph records show how temperature changed as the storm passed revealing the presence of warm and cold fronts in the system. Reasons are given why this storm maintained its energy so long after it passed inland contrary to the usual behaviour of tropical cyclones on passing to land. Associated with the main storm there was observed a minor trough which moved parallel with the main centre. It is suggested that this trough may have arisen from another circulation within the main storm. A. E. M. G.

702. Effect of earth's rotation on wind-direction near ground. R. Faillettaz. *Comptes Rendus*, **209**, *pp.* 767–769, *Nov.* 20, 1939.—A very sensitive type of anemometer was used to measure the direction of the wind relative to that of the pressure gradient on smooth ground (the beach at La Baule). The angle of deviation was found to change by 20° between heights of 1 and 30 cm. above ground-level for winds of 3 to 5 m./sec. and by 10° between 1 and 15 cm. for winds of 8 to 12 m./sec. The wind-velocities were determined at 1 m. above ground level. It is concluded that, for plane ground, there is a layer some 10 to 20 cm. thick analogous to the limiting layer in the hydrodynamics of the motion of fluids in smooth canals. This layer is independent of the turbulent layer of thermal or orographic origin. G. C. McV.

703. Effect of radiation on psychrometric readings. D. Dropkin. *Cornell Univ. Eng. Exp. Sta., Bull., No.* 26, [60 *pp.*], *Oct.*, 1939.—Experiments are described for determining the effect of radiation on the readings of both the wet- and dry-bulb thermometers of a psychrometer. It is shown that the true dry-bulb temperature t_a can be computed from the equation,

$$t_a = t - (0{\cdot}3\,105/V^{0.56})\,[(T_w/100)^4 - (T/100)^4]\,(D/0{\cdot}235)^{0.44},$$

where t is temperature of thermometer bulb exposed to radiation, T_w is absolute temperature of the wall of the enclosure and T is absolute temperature of the bulb exposed to radiation (all in °F.), D is the dia. of the bulb (inches) and V the air velocity (ft./min.). The wet-bulb temperature is given by

$$t' = t - (1 + h_r/h_g)\,(e' - e)\,(t - t_1')/(e_1' - e),$$

where t' is the wet-bulb temperature shielded from radiation, t the dry-bulb temperature of the air-vapour mixture, h_r is the coefficient of heat transfer by radiation and h_g the coefficient of heat transfer by convection, e' the vapour pressure corresponding to the wet-bulb temperature t', e the partial vapour pressure of the air-vapour mixture, and e_1', the vapour pressure at the exposed wet-bulb temperature, t_1'. It follows that the radiation error cannot be expressed as a percentage of the wet-bulb depression without stating the wet-bulb temperature. R. W. P.

704. Local distribution of thunder rains round Nottingham. A. B. Tinn. *Roy. Meteorolog. Soc., J.*, **66**, *pp.* 47–64; *Disc.*, 65, *Jan.*, 1940.—A belief exists in Nottingham that there is some relation between the paths of thunderstorms and the valley of the River Trent. This investigation was made with a view to testing this speculation and to discovering whether any tendency did exist in the local distribution of thunder rains round Nottingham. Information was obtained from 34 rain gauges for thunder days over a period of ten years, and the data charged and analysed. It is found that there are areas which appear to be more subject to heavy thunder rains, and also areas having a comparative immunity. There

seems to be more basis for the belief that these rains do tend to be heavier near the River Trent, but this tendency is more marked for the stretch of valley between the confluences of the rivers Erewash and Leen with the Trent. Eastwards of the Leen the river valley appears to be less subject to the heaviest falls. AUTHOR.

705. Ablation of snow under the vertical sun in Hawaii. C. K. WENTWORTH. *Am. J. Sci.*, **238,** *pp.* 112–116, *Feb.*, 1940.—Late in July, 1939, snow-banks in the summit area of Mauna Kea, Hawaii, were found to be deeply pitted by ablation. The pits, or suncups, ranged to 4 ft. deep, and with intervening spikes, were not only precisely vertical but also strikingly oriented on line with the east to west movement of the vertical sun, these attitudes being independent of the direction and amount of the slope of the ground, or of local direction of the wind. Testimony of other observers indicates that these snow forms were produced in not over a week's time. Recorded observations are insufficient to indicate whether formation of such suncups and sunspikes is usual at a certain seasonal stage of wastage of the snow, or is exceptional. AUTHOR.

706. Absolute brightness of night-sky at Godhavn (Ile Disko, Greenland N.W.). H. GARRIGUE. *Comptes Rendus*, **209,** *pp.* 769–771, *Nov.* 20, 1939.—The photometer used is described. The measurements were made in the winter and spring of 1938–39. Comparison with measurements made at the Pic du Midi show that the arctic sky without aurora is brighter than that of the Pic du Midi. The permanent aurora is therefore more brilliant in the arctic. The colour of the night-sky is always redder than solar light. G. C. McV.

707. Excitation conditions of the nitrogen spectrum in the upper atmosphere. J. CABANNES AND R. AYNARD. *J. de Physique et le Radium*, **10,** *pp.* 455–458, *Nov.*, 1939.—The excitation conditions of the molecular spectrum of N_2 in the light from the night sky are sought. An explanation is required as to why the lower level of the Kaplan bands, which appear with greatest intensity in the sky has for the quantum of vibration, $v = 2$ or 3. The energy liberated by the recombination of atoms of O during the night is interposed. While submitting that this recombination results from a triple collision with a molecule of N_2 and that the molecules O_2 and N_2 share the energy set free, the various forms which this hypothesis can assume, and the support they give to laboratory tests, are discussed. Finally an explanation is provided for the remarkable excitation of the band 6 500–6 550Å of the first positive system. R. S. R.

708. Photo-electric measurements of daylight under alpine conditions. W. R. G. ATKINS AND M. ROTHSCHILD. *Roy. Meteorolog. Soc., J.*, **66,** *pp.* 13–20; *Disc.*, 20–21, *Jan.*, 1940.—Observations have been made with vacuum Na and with rectifier Se photocells, under opal flashed glass diffusing plates. The former may remain constant save when exposed to intense tropical desert heat and full sunshine for a long period. The latter are far less constant, and in time the curvature of the light-current relation may increase; this is accompanied by a decrease in blue and green sensitivity so that the response at the long-wave end of the spectrum becomes relatively greater. No serious temperature error is introduced when the current from a Weston Se cell is measured with a 10 ohm galvanometer amid snowy surroundings. Na cell measurements at about 0·41 μ give the reflection from the snow as being from 0·74 to 1·19 times the vertical component of mixed daylight. With a Se cell, sensitive throughout the spectrum, observations ranged from 0·68–0·88. Calculated on the maximum values

for mixed daylight the snow reflections were from 0·38–0·74 and from 0·28–0·38 respectively for the Na and Se cells. Under Alpine conditions there is relatively less scattered light from the sky, consequently the sun/sky ratio is greater, in the violet, than in England or Ceylon for the same solar altitude ; with the Se cell the sun/sky ratio is even greater, with a maximum of 9·70, as against 3·55 for the violet, both determinations being made at Scheidegg (2064 m.) with an absolutely cloudless very dark blue sky, solar altitude 48·1°. The vertical component of daylight is higher in the violet, under Alpine conditions, than in Ceylon, for low or moderate solar altitudes, but the differences is less at higher solar altitudes. For measurements covering the whole spectrum the Alpine values are also noticeably higher. The physiological effects of Alpine sunlight are due partly to the intensity of the reflected light. AUTHORS.

***709. Simple sky-radiation recorder.** D. J. MACLEAN. *Journ. Sci. Instruments*, **17**, *pp.* 40–41, *Feb.*, 1940.—A photocell in a special mounting has been used in conjunction with a Cambridge thread recorder to give a continuous record of the intensity of sky radiation. The arrangement has provided a quantitative link between the solar radiation incident on samples of bituminous road material and the consequent changes in their properties. AUTHOR.

***710. Sensitive aneroid diaphragm capsule with no deflection above a selected pressure.** W. G. BROMBACHER, V. H. GOERKE AND F. CORDERO. *Bureau of Standards, J. of Research*, 24, *pp.* 31–32, *Jan.*, 1940.—A sensitive diaphragm capsule has been designed in which the two corrugated diaphragms nest into each other at external air pressures above a desired value. Evacuated capsules of this type have particular application in measuring pressure with radio sondes of the Diamond-Hinman-Dunmore type [see Abstract 1936 (1938)], where the deflection of the contact arm is fixed. At the ground level the diaphragms are designed to nest into each other and deflection does not begin until the air pressure is reduced to the value called the cut-off pressure. Several elements of two capsules each were constructed with a cut-off pressure of 140 millibars. When installed in a radio sonde in place of the usual type, which is responsive over the entire range of pressures, a 7-fold increase in sensitivity in pressure measurement was obtained at altitudes above 46 000 ft. AUTHORS.

See also Abstracts 629, 630, 695, 718.

SEISMOLOGY.

711. Theoretical treatment of earthquakes. M. TOPERCZER. *Akad. Wiss. Wien, Ber.*, **148**, 2a, 1–2, *pp.* 1 32, 1939. –The results obtained by earlier writers on the mathematical treatment of the initial phase are reviewed. The conditions used are specified and a disturbance function for the motion is obtained. The equation for the pendulum motion is next derived and with the help of these formulae the complete solution of a special case of surface movement is obtained. Difficulties of a mathema tical nature do not occur in spite of the complicated assumptions made but numerically there are difficulties in the solution of the equation. After a general discussion of the solution, the initial magnification obtained and the phase displacement of the pendulum are examined, and the results compared with other solutions. R. S. R.

***712. Sensitivity and frequency characteristics of new electrodynamic seismometer.** H. MARTIN. *Phys. Zeits.*, **40**, *pp.* 577–582, *Sept.* 15, 1939.—A new seismometer is described in detail together with the relevant

theoretical treatment. The description is illustrated by 10 diagrams which show the sensitivity and frequency characteristics. The advantages of the instrument are discussed very thoroughly. H. H. Ho.

713. Registrations of Central European seismographic stations and their physical interpretation. G. Schmerwitz. *Phys. Zeits.*, **40**, *pp.* 611–615, *Oct.* 1, 1939.—There are 5 unknown physical quantities involved in an earthquake : the coordinates of the focus, the time of the shock and the velocity of the elastic waves. Thus 5 different stations at least are needed if all these quantities are to be determined. A number of earthquakes in Southern Germany and in the Alps were investigated by this method of simultaneous registration. From the results it follows that the crust of the earth has a depth of very nearly 50 km. in that region. The distribution of stresses round the focus could also be inferred. It was found that the focus is the seat of shearing stresses. In all observed cases of Central European earthquakes the depth of focus was less than 50 km., and the direction of the stress horizontal, whereas in Japanese earthquakes apparently the depth of focus always exceeds 50 km., and the direction of the stress is near the vertical. L. E. F.

714. Rayleigh waves across the Pacific Ocean. K. E. Bullen. *Roy. Astron. Soc., M.N., Geophys. Supplement*, **4**, *pp.* 579–582, *Dec.*, 1939.—An analysis has been made of the dispersion of Rayleigh waves recorded at Wellington from the Bering Sea earthquake of Nov. 10, 1938. Using dispersion curves of Jeffreys based on a hypothetical structure corresponding to an upper layer of granite resting on a mantle of olivine, the indicated crustal thickness for the Pacific region involved was about 18 km., as compared with a thickness 8 to 10 km. greater found by Jeffreys for Eurasia on the same hypothesis. This difference of thickness is in agreement with Stoneley's comparison of the two regions using Love waves. The use of dispersion curves of Sezawa, which would fit a somewhat denser crustal layer, would indicate a thickness of order 26 km. for the Pacific region in question. Author.

***715. New instruments and equipment at Co-operative Seismograph Stations of the U.S. Coast and Geodetic Survey.** J. H. Nelson and H. E. McComb. *Seismological Soc. of America, Bull.*, **29**, *pp.* 549–557, *Oct.*, 1939.—Full details and views are given of (1) an experimental model McComb-Romberg tilt-compensating seismometer installed at the new seismograph station at Lincoln, Nebraska ; (2) a new tilt-compensating seismograph at Chicago and Salt Lake City, and (3) improvements to the equipment of the tilt-compensating seismometers at Bozeman, Montana. In each case a single recorder is used for both components. R. S. R.

***716. Universal vertical seismograph.** G. Grenet. *Comptes Rendus*, **209**, *pp.* 895–896, *Dec.* 11, 1939.—For stations possessing only horizontal seismographs, a vertical apparatus analogous to the Wenner type described earlier [Abstract 1081 (1939)] has been constructed. The characteristics are determined by the period and decrement of the galvanometer, the adjustment of the period and decrement of the pendulum being made approximate. By combining the 2 registrations full details are obtained. The amplification is limited to 700 on account of microseisms. It has given good results for an epicentre 700 km. distant but no occasion had arisen for near earthquakes. R. S. R.

See also Abstract 696.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

717. Direction-finding of sources of atmospherics and South African meteorology. B. F. J. Schonland and D. B. Hodges, assisted by G. A. Cruickshank, L. Katz, J. W. van Wyk, W. E. Phillips and R. A. Jubb. *Roy. Meteorolog. Soc., J.*, **66**, *pp.* 23–41 ; *Disc.*, 43–46, *Jan.*, 1940.—An account is given of investigations on the location of sources of atmospherics in South Africa with visually-operated cathode-ray direction-finders, extending over a period of 15 months and employing stations in Johannesburg, Durban and Bulawayo. The accuracy with which a thunderstorm source can be located by this method was found to be $\pm$ 50 km. for storms at distances less than 750 km. At greater distances the accuracy decreases but is usually less than $\pm$ 100 km. at 1 500 km. Of the land sources 76% were identified with thunderclouds and 18% with nimbus cloud. Sources over the oceans were found to be closely associated with areas of low pressure, 89% of such lows having associated sources. The progress of the lows could be followed by this method for several days. Their associated sources in the majority of cases lay in the warm sector from NNE. to ESE. of the centre of the low. The monthly and seasonal distributions of sources over the land agree with the distributions found by Brooks from thunderstorm data, except that over the Indian Ocean the number of atmospherics sources reaches a maximum in the winter. A discussion is given of the possibilities of the device in meteorology in Southern Africa and of difficulties encountered in the practical day-by-day use of the system. A commentary (*ibid. pp.* 41–43) follows by N. P. Sellick, J. S. Peake, and R. A. Jubb, of the Rhodesian Meteorological Service. Authors.

718. Association of meteorological changes with variations of ionization in the F_2-region of the ionosphere. J. Bannon. A. J Higgs, D. F. Martyn and G. H. Munro. *Roy. Soc., Proc. A*, **174**, *pp.* 298–309, *Feb.* 15, 1940. —A study has been made of the day-to-day variations in the noon values of the maximum electron density in the F_2-region of the ionosphere, at two observing stations near Sydney and Canberra. The small number of days on which these values are affected by association with magnetic storms are excluded from the analysis. Large day-to-day fluctuations, amounting sometimes to 50%, remain at each station. It is found that these fluctuations are associated with meteorological changes observed at the ground. Over 19 months of daily observations it is found that on days when the region between lat. 29°S. and lat. 36°S., and long. 140°E. and long. 156°E. is free from " frontal " conditions, the values of F_2-ionization are higher on the average by 6% near Sydney and 11% near Canberra than on other days. A similar difference is found in the averages for each month, except in Aug. 1937 and July and Aug. 1938, when a small negative difference occurs at each station. The difference is greatest in the equinoctial months when it amounts to about 20% for Stromlo. It is found that while the values of ionization density measured at Sydney and Canberra are usually equal, there is a strong tendency for the Canberra values to be lower than the Sydney values on " frontal " days. This result is considered surprising, since the observing stations are only 250 km. apart. The theoretical difficulties in the way of an explanation of the association here found between F_2-ionization and meteorological conditions are discussed. It is pointed out that the results suggest that current views concerning the seasonal variation of F_2-ionization in various regions of the earth may require revision. The current view regards the

F_2-region ionization as normally influenced solely by the intensity of solar radiation, thus depending in magnitude solely on latitude. The results here presented suggest that local climatological factors may exert a profound influence on the magnitude, and on the seasonal and diurnal variations of F_2-ionization. AUTHORS.

719. Summary of the year's work, Department of Terrestrial Magnetism, Carnegie Institution of Washington. J. A. FLEMING. *Terr. Mag.*, **44**, *pp.* 405–410, *Dec.*, 1939.—The department has had a large share in the production of two treatises, *Geomagnetism*, by Chapman and Bartels, and *Terrestrial Magnetism and Electricity*, edited by the author. The two volumes will supplement each other. Geomagnetic measurements extending over sediments representing 1 000 years in glacial times indicate that the direction of the earth's field then was not markedly different from what it is now. The department in co-operation with the geophysical department made a magnetic survey round the Santa Maria volcano in Guatemala. Variations of 15% in V showed high correlation with known structural features of the region. The solar and lunar diurnal variations in H at Huancayo are being studied in detail in order to deduce corresponding changes in the physical state of the ionosphere and in the ionizing radiation. An investigation was made of the world-wide disturbance fields of certain magnetic storms, using data of 4 storms of the polar year 1932–3. Useful derivations were obtained of the form and intensity of the currents assumed to flow within the atmosphere. The intensity of cosmic radiation is always lower for the 5 international magnetically disturbed days than for the 5 quiet days of each month. On the average the intensity is lowered on days of magnetic disturbance. All evidence indicates that the major changes in cosmic activity are world-wide, and are due to a part of the field of magnetic disturbance external to the earth. In terrestrial electricity further information was sought as to the electric "current" which maintains the negative charge of the earth. The average magnitude of the total supply current is about 1 800 A. In connection with the volcano referred to, the range in the variations of the potential-gradient in the earth near the volcano on normal days far surpasses that in any other registrations of earth potentials. Large fluctuations of simultaneous values of ion density in the F_2-region at Watheroo and Canberra demonstrate that observations from one station are not representative of more than a certain limited area of this region. With the installation of the wide-band automatic ionospheric recorder at Watheroo it was found that 2 hours before sunrise a bank of ions of about 10 000 electrons per cm^3. moves down from the 250 km. level, comes to rest at about 140 km. in about an hour, decreasing in density. At sunrise the ion density increases and the region is recognized as that of F_2. This again moves down with decrease in ion density, revealing the fact that such movements and separation of ion banks can occur in the absence of direct sunlight. During intense magnetic storms violent ionospheric effects were observed at the geomagnetic equator. The new h.v. constant-potential equipment has been employed in studies of the process of nuclear fission in U and Th. Delayed emission of neutrons has been observed and the scattering of neutrons by protons measured. The apparatus has also been applied in co-operative research in other sciences. Plans for a large cyclotron have been prepared. G. E. A.

See also Abstracts 690, 691, and

360B. Bearings of the discharge phenomena giving rise to atmospherics. F. Schindelhauer.

RADIOACTIVITY.

720. He determination in rock-salt and sylvite. F. Koczy. *Akad. Wiss. Wien, Ber.*, **148,** 2a, 1–2, *pp.* 89–105, 1939.—Includes an account of the purification, test of purity and pressure measurement of the He. For rock-salt the He content is about 10^{-6} cm^3./gm., for sylvite 10^{-5} cm^3./gm. The He content varies from place to place, probably due to the different lyes from which the salts crystallize out. No difference is found in the He content of blue and white rock-salt. J. E.

721. Fission of heavy nuclei. G. Cocconi. *N. Cimento*, **16,** *pp.* 417–436, *Aug.–Sept.–Oct.*, 1939.—The paper gives a fairly extensive account of our present knowledge of the subject, including theoretical considerations, identification of the products, trans-uranium elements, emission of neutrons during the reaction and after it, emission of β- and γ-rays, and chain reactions. A list of about seventy references is included. E. E. W.

722. Fission products of U and Th. O. Hahn. *Ann. d. Physik*, **36,** 3–4, *pp.* 368–372, *Oct.*, 1939.—Several points connected with the fission of U and Th. by neutrons are discussed. It is suggested that, if a photographic emulsion could be produced sensitive to the heavy products of the U fission but insensitive to α- and β-particles, it would be useful for the examination of disintegrations produced by cosmic rays. The inert gases Kr and Xe are products of the fission. The unstable Kr transforms to Ru, and so by measuring the activity of the Ru outside the target a measure of the diffusion of Kr in the target can be obtained. This result is free from the complication of Ru atoms ejected by recoil, which is the case in the measurements with radon and thoron. W. E. D.

723. Collapse of U and Th nuclei into lighter atoms. O. Hahn and F. Strassmann. *Phys. Zeits.*, **40,** *pp.* 673–680, *Nov.* 15, 1939.—Although there is evidence of formation of as many as 14 different elements in U disintegration, this number cannot be regarded as exhaustive and the presence of trans-uranian elements 93 and 94 is not precluded. Only in the cases of 3 hr.-Kr and 14 min.-Ba was it possible to attempt different chemical reactions for the splitting. Accurate data are particularly lacking in the cases of the Pd, Rh, Ru, group; the first-formed rare-earths; Nb and Zr. Tables are given for formation of Xe-Cs-Ba, Sr-Kr, Sb-Te-I isotopes. From Th fewer atom types are obtained, mainly owing to the lower intensity of the products; collapse occurs only with rapid electrons. The authors suggest a comparison of elements produced in the disintegration of the two nuclei. D. R. H.

724. Interaction of fast neutrons with U nuclei. L. Goldstein, A. Rogozinski and R. J. Walen. *J. de Physique et le Radium*, **10,** *pp.* 477–486, *Nov.*, 1939.—A source of Po + Be and an ionization chamber filled with H_2 under a pressure of 35 atm. have been used to study the elastic and inelastic diffusion of neutrons from U. The possibility of using this method to demonstrate the liberation of neutrons from U under bombardment with fast neutrons is discussed. It is concluded that this method of U disintegration is possible, but that too little is known of the inelastically diffused neutrons to allow of the process being detailed. The total cross-section for neutron diffusion has been found to be 11×10^{-24} cm^2., which is much greater than that to be expected from an extrapolation from neighbouring heavy elements. This implies that chain reactions, if such are possible, could be observed with a mass of U much less than that previously supposed to be necessary. G. O. B.

725. Angular distribution of transmuted particles in transformation processes of light nuclei. H. NEUERT. *Ann. d. Physik*, **36**, 5, *pp.* 437–461, *Nov.*, 1939.—Experiments have been made to discover whether the angular distribution of transmuted particles is connected with the energy of the colliding particles. The processes studied were $Li^6(D^2\,;\,p)Li^7$, $D^2(D^2\,;\,p)H^3$, and $B^{11}(p\,;\,\alpha)Be^8$, energies up to 300 kV being used. In the process $Li^6(D^2\,;\,p)Li^7$, the abundance ratio for a very thin film is 1·9–2 for energies of 180 and 290 kV. In the case of the second of the above processes there is asymmetrical angular distribution at voltages less than 40 kV. In the case of $B^{11}(p\,;\,\alpha)Be^8$ there is a strong resonance-like maximum of the abundance ratio for 170 kV. A. J. M.

726. Periods of radiorhodiums and radiosilvers obtained by bombardment with slow neutrons. J. B. RAJAM, P. C. CAPRON AND M. DE HEMPTINNE. *Ann. Soc. Sci. de Bruxelles*, **59**, *pp.* 403–417, *Dec.*, 1939.—The periods, T, of the radioelements resulting from the bombardment with slow neutrons of Rh and Ag are respectively $4{\cdot}34 \pm 0.06$ min. and $44{\cdot}6 \pm 0{\cdot}8$ sec., and $2{\cdot}44 \pm 0{\cdot}06$ min. and $24{\cdot}2 \pm 0{\cdot}5$ sec. Possible sources of error and means of eliminating them are discussed in detail. C. A. S.

727. γ-rays from Be and N bombarded with deuterons. H. R. CRANE, J. HALPERN AND N. L. OLESON. *Phys. Rev.*, **57**, *pp.* 13–15, *Jan.* 1, 1940.—Measurements have been made on the Compton electrons ejected from a thin lamina of C by the γ-rays from Be + D and N + D. Lines at 3·45 and 1·0 eMV were found in the case of Be + D and lines at 8·2, 6·6, and 5·1 eMV were found in the case of N + D, with a slight indication of two other lines at 4·1 and 2·5 eMV. Possible ways in which these lines may be correlated with the energies of the heavy particles emitted are discussed. AUTHORS.

728. Nuclear isomerism in Se and Kr. A. LANGSDORF, JR. AND E. SEGRÈ. *Phys. Rev.*, **57**, *pp.* 105–110, *Jan.* 15, 1940.—A study has been made of the radioactive chain $Se^{83} \rightarrow Br^{83} \rightarrow Kr^{*83}$. The last member is an isomer of the stable Kr of mass 83. An isomeric pair $Se^{79 \text{ or } 81}$ has been found and the two genetically related nuclear isomers have been separated chemically. Kr^{83} and Br^{83} are produced by the fission of U and Th as well as by the bombardment of Se with deuterons and slow neutrons. AUTHORS.

729. Neutrons from disintegration of F by deuterons. T. W. BONNER. *Roy. Soc., Proc. A*, **174**, *pp.* 339–351, *Feb.* 15, 1940.—The neutrons from the disintegration of F by deuterons have been investigated by the method of observing He or H recoils in a high-pressure cloud chamber. When targets containing F were bombarded with 950 kV deuterons, several groups of neutrons were observed. The disintegration Q values computed from the energies of the neutron groups are 10·80, 9·33, 6·62, 5·39, 3·53, 1·84 and 0·74 MeV. The nuclear reaction appears to be $(F^{19}, H^2, Ne^{20}, n^1)$. The disintegration value $Q = 10{\cdot}80 \pm 0{\cdot}20$ MeV corresponds to a transition to the ground state of Ne^{20} and smaller Q values indicate excited states in Ne^{20} at 1·5, 4·2, 5·4, 7·3, 9·0 and 10·1 MeV. Only a small fraction of the neutrons belong to the group of maximum energy. The excited states in Ne^{20} at 5·4, 7·3, 9·0 and 10·1 MeV are unstable against α-particle emission and so they may break up into O^{16} and an α-particle. The experimental width of the level in Ne^{20} and 10·1 MeV appears to be not greater than about 0·2 or 0·3 MeV. AUTHOR.

730. Range groups of natural H-rays. T. Sexl and P. Urban. *Zeits. f. Physik*, **113**, 9–10, *pp.* 554–561, 1939.—Discussion of the researches carried out up to the present on the scattering of α-particles in H_2 shows that the results can be completely accounted for by the Guth-Sexl dispersion theory. From the standpoint of this theory further detailed dispersion investigations are desirable. A. W.

731. β- and γ-rays of active deposit of thoron. R. Arnoult. *Ann. de Physique*, **12**, *pp.* 241–388, *Oct.–Nov.*, 1939.—The discrete and continuous spectra of thoron active deposit and of Th(C + C′ + C″) are examined by semi-circular focusing, a pair of Helmholtz coils being used to produce the magnetic field. The paper is divided into 4 parts. Firstly, an absolute measurement is made of the energy of the β-ray, usually denoted by F, in the transformation ThB → C. The value obtained is 146·6 ekV with an accuracy of 2% and this is compared with previous results. Secondly, the intensities of some of the main β-rays from a thoron active deposit are measured by means of a Geiger-Müller counter, and, by correlation with photographic plate measurements, the corresponding quantities for a large number of other rays are measured up to a maximum of about 265 ekV this upper limit being set by the safe current that can be passed through the coils producing the magnetic field. Thirdly, using a Geiger-Müller counter, the continuous spectrum of the transformation ThB → C is studied in detail within the limits 341 ekV to 10ekV. The number of electrons in the low energy region of the spectrum is found to be larger than that calculated from either the Fermi or the Konopinski-Uhlenbeck formula. In this section detailed consideration is given to the sharpness of focus, solid angle, structure of the focused line as related to the shape of the source, and scattering of slow electrons in the apparatus—in the design of the apparatus particular attention is paid to this point. Fourthly, level schemes with energies and spins are set up for ThC, ThC″ and ThD from consideration of the work of the author and of previous workers on the γ-ray energies and internal conversion coefficients, together with the α-ray energies and the demands of theory. Throughout the paper detailed comparisons are made with the results of previous experimenters. W. E. D.

***732. Design of magnetic β-ray spectrometer.** J. L. Lawson and A. W. Tyler. *Rev. Sci. Instruments*, **11**, *pp.* 6–18, *Jan.*, 1940.—A magnetic β-ray spectrometer of high resolution has been constructed. The theory of the resolution of this instrument has been investigated in detail and applied to the design of the slit system. The effects of scattering within the vacuum chamber have been studied and reduced to a negligible value. The corrections for the efficiency of the Geiger-Müller counter and for the absorption in the counter window have been obtained as a function of the momentum of the incoming particles. Authors.

***733. Theory of electrostatic β-particle energy spectrograph. Part II.** F. T. Rogers, Jr. *Rev. Sci. Instruments*, **11**, *pp.* 19–22, *Jan.*, 1940.—This paper is a discussion of the effects, on the use of the electrostatic energy spectrograph for charged particles, of the field distortions at the edges of the spectrograph plates and in between the plates. These effects are evaluated and shown not to be negligible in measurements of highest precision. It is shown how to eliminate these effects to the extent of a first approximation by properly locating the source and detector of charged particles. The discussion is carried through for only one particular

form of spectrograph plates, but the modifications necessary to make it applicable to any other form of spectrograph are adequately pointed out. [For Part I see Abstract 1156 (1937).] AUTHOR.

*734. **Cloud-chamber for lecture experiments.** R. HILSCH. *Phys. Zeits.*, **40**, *pp.* 594–595, *Sept.* 15, 1939.—The author describes in detail a very efficient experimental cloud-chamber capable of demonstrating to large audiences the orbits of α-particles. Photographs of the chamber and of the α-orbits from RaC′ are included together with two working diagrams. H. H. Ho.

735. **Action of radon on polymethylenes—cyclobutane and cyclobutene.** G. B. HEISIG. *J. Phys. Chem.*, **43**, *pp.* 1207–1212, *Dec.*, 1939.—The synthesis of cyclobutane and of cyclobutene has been simplified, thereby increasing the yield threefold. These gases polymerize to liquids whose viscosity and colour increase with the time of bombardment by α-particles from radon. The $-M/N$ value of cyclobutane with a heat of formation of 16·8 cal. is 2·3, and that of cyclobutene, having a heat of $-6{\cdot}0$ cal., is 7·4. These values agree with the relationship previously noted. The values of the ratio $\Delta(H_2 + CH_4)/ - \Delta HC$ decrease consistently with the increase in the $-M/N$ value. AUTHOR.

See also Abstracts 601, 661, 681, 699.

RADIATION.

ABSORPTION.

736. **Optical absorption of superconducting tin layers.** R. HILSCH. *Phys. Zeits.*, **40**, *pp.* 592–594, *Sept.* 15, 1939.—A change in the transmission of light through thin layers of Sn has not been detected by transition from the normal into the superconducting state for the spectral region of 380–900 mμ. In like manner, colloidal Pb and Tl in crystals of KCl exhibit no change of absorption spectra at He temperatures. H. H. Ho.

737. **Optical properties of quartz at wavelengths of 8–20 μ.** W. STEIN. *Ann. d. Physik*, **36**, 5, *pp.* 462–484, *Nov.*, 1939.—The transmissibility of crystalline and amorphous quartz in the infra-red has been investigated. The transmissibility of crystalline quartz shows a strong dichroism, and the substance is particularly transparent to light of wavelength 16·5μ. Quartz glass does not show a similar maximum, The absorption coefficients for crystalline and amorphous quartz have been determined for various wavelengths, and the absorption curves have been obtained. A. J. M.

COLORIMETRY.

738. **Colorimetric determination of arsenic in ferrous and non-ferrous alloys.** C. J. RODDEN. *Bureau of Standards, J. of Research*, **24**, *pp.* 7–11, *Jan.*, 1940.—A method is described for the determination of As and has been applied successfully to Fe, steel, Cu-base alloys, Sn- and Pb-base bearing metals, and pig lead. The arsenic is first separated from the other constituents of the material by distillation as the trichloride. It is then oxidized to arsenic acid and converted to a blue As-Mo compound by treatment with a solution containing hydrazine sulphate and ammonium

molybdate. The transmittency of the coloured solution is measured with a photoelectric colorimeter, and the amounts of As read from a curve obtained by using known amounts of As. Alternatively, the colour may be matched against standards by means of a visual colorimeter. The method is reasonably rapid and is applicable to amounts of As as small as 2 μgm. AUTHOR.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

739. Magnetic rotation of chlorides of Pr, Sm and Eu in aqueous solution at 25°. C. M. MASON, J. W. HICKEY AND W. K. WILSON. *Am. Chem. Soc., J.*, **62**, *pp.* 95–99, *Jan.*, 1940.—The authors give data for molecular and specific rotations at concentrations 0–3·5 molal, for six wavelengths in the range 4 811–6 438 Å, except in those cases where absorption interfered. The refractive indices of these solutions at 25° are also given. The calculated Verdet constants are positive for Sm and Eu solutions and negative for Pr solutions, when referred to water. Eu shows an anomaly, relative to Sm and Pr, in a comparison of the Verdet constants with the known magnetic moments of the ions. N. M. B.

EMISSION.

740. Partial and total emission. A. CARRELLI. *Accad. Lincei, Atti*, **29**, *pp.* 664–671, *June* 17, 1939.—The emission of some substances has been studied as function of the wavelengths between 1 and 7μ and of the temperature between 500°K. and 1 200°K. The substances under consideration were the sulphates of Ca and Sr and the oxides of Mg, Ca, Be, Zn, Fe and Cu. The results are shown in curves, and an interpretation of the maxima of emission is given. It is shown that the emission maximum at 4·65μ of the sulphate which is due to an inner vibration of the SO_4 group, behaves like the black-body radiation as function of the temperature. [See Abstract 427 (1940).] L. K.

741. Cosmic rays. *Rev. Modern Physics*, **11**, *pp.* 121–303, *July–Oct.*, 1939. A series of 30 papers and a foreword contributed to a symposium held at Chicago University in June, 1939.

" Foreword," by A. H. COMPTON (*p.* 122).

PART I. INTENSITY OF COSMIC RAYS.

" Absolute value of cosmic-ray ionization at sea-level in different gases" and " Intensity of cosmic radiation under thick layers," by J. CLAY (*pp.* 123–135).—These two papers discuss and give values of various observers for the ionization at sea-level varying from 0·5–3 I (ions per cm^3. per sec.). Factors such as wall-effects are duly considered and values for argon and air in a closed iron vessel at 770 mm. of Hg pressure at sea-level at Amsterdam were 2·3 $\pm$ 0·05 I and 1·56 $\pm$ 0·05 I. In open air this gives 1·63 $\pm$ 0·05 I at 760 mm. Hg pressure. A detailed series of experiments on the intensity of cosmic radiation under thick layers of material leads to the conclusion that the most penetrating component must be attributed to particles other than electrons or mesotrons and the suggestion of protons is put forward with reserve.

" Cosmic rays on the Pacific Ocean," by A. H. COMPTON AND P. S. GILL (*p.* 136).—Describes experiments to detect differences of about 0·5% in the intensity in the northern and southern hemispheres such as would accompany independence of cosmic rays on galactic rotation. No detect-

able variation was found to 0·1% and the conclusion is either that the motion of the sun with the galaxy is much slower than has been generally supposed, or that the cosmic rays share in the galactic rotation. Both views have their supporters.

" Stable periodic orbits in the theory of primary cosmic radiation," by A. Baños, Jr., H. Uribe and J. Lifschitz (*pp.* 137–148).—Calculations are made considering only the motion of the particle in its own meridian plane. For the purposes of the numerical computations, the Goursat type of conformal transformation of the co-ordinates, as introduced by Störmer, is used.

" Fine-structure pattern of directional cosmic-ray intensity," by E. J. Schremp and H. S. Ribner (*pp.* 149–152).—Theoretical and experimental work on this subject is summarized. The experimental results establish the existence of a fine-structure pattern and the value of the method in providing evidence on the existence of charged particles of both signs is emphasised. [See Abstract **742** (1940).]

PART II. TIME VARIATIONS OF COSMIC RAYS.

" Significance of variations in cosmic-ray intensity and their relation to solar, earth-magnetic and atmospheric phenomena," by V. F. Hess (*pp.* 153–157).—As a result of A. H. Compton's world-wide survey and Hess's work on the Hafelekar, it has been proved that regular and irregular variation of the cosmic-ray intensity occurs with time and that part of these variations occurs simultaneously over the entire globe. These world-wide changes are taken as evidence of extra-terrestrial origin of the rays and interesting conclusions about the relationship of cosmic-ray intensity with solar and geomagnetic phenomena are predicted.

" Variations of cosmic-ray intensity with variation of barometric pressure and temperature at sea level," by J. Clay and E. M. Bruins (*pp.* 158–159).—An experimental examination is made, three ionization chambers being used, two under 110 cm. of Fe and one under 12 cm. of Fe. A diurnal variation parallel with temperature is found only in the last arrangement. A long-period variation with temperature and pressure is shown by all three instruments. The barometric coefficient is −6·4% per cm. Hg and the temperature coefficient is −0·21% per °C. No explanation seems forthcoming of the large barometric variation.

" Present status of solar and sidereal time variation of cosmic rays," by E. O. Wollan (*pp.* 160–165).—The solar time variation has been well established by many experimenters but the evidence for a sidereal diurnal variation is still considered to be inconclusive.

" Seasonal cosmic-ray effects at sea level," by R. A. Millikan, H. V. Neher and D. O. Smith (*p.* 166).—Results of experiments, which are in agreement with those of Forbush, show (*a*) an equatorial dip of 7% on the Western side and 8% on the Eastern side of South America, (*b*) no seasonal variation in the sea-level effect between Los Angeles and the Straits of Magellan, and (*c*) constant intensity in summer and autumn between Los Angeles and Vancouver. A Neher self-recording electroscope with a 10 cm. shield was used.

" Seasonal studies at high altitudes," by W. P. Jesse (*p.* 167).—Unmanned balloons, equipped with spherical ionization chambers were used for these studies. Changes in intensity were observed but definite assignment to seasonal causes is considered premature.

" World-wide changes in cosmic-ray intensity," by S. E. Forbush (*pp.* 168–172).—Denoting the irregular world-wide component by W various results are surveyed ; high correlation is shown to exist between changes in the monthly means of W over a wide area. The association between W and terrestrial magnetic activity is considered.

" Recurrence phenomena in cosmic-ray intensity," by A. T. Monk and A. H. Compton (*pp.* 173–179).—An examination is made using Chree's method. The high correlation established between the intensity of cosmic-ray ionisation at one time and that found about one synodic rotation of the sun later, is a recurrence phenomenon, but not necessarily a true periodic phenomenon. The possibility, however, of at least a semi-periodicity is suggested by the persistence in pulse amplitude.

" Theory of world-wide periodic variations of the intensity of cosmic radiation," by M. S. Vallarta and O. Godart (*pp.* 180–190).—A review of the evidence is given and calculations are made with special consideration of the effect on the cosmic rays of the sun's permanent magnetic field. The effect of the earth's magnetic field is also considered. It is concluded that the temporal variations in cosmic-ray intensity can be accounted for, although a discrepancy of a 3-months phase difference still exists between the observed and calculated seasonal variation.

PART III. COMPOSITION OF COSMIC RAYS.

" Nature of cosmic-ray particles," by S. H. Neddermeyer and C. D. Anderson (*pp.* 191–207).—The evidence that cosmic radiation contains electrons, positrons and mesotrons is reviewed and a discussion is given of certain difficulties which exist in the interpretation of cosmic-ray particles as electrons and mesotrons of unique mass.

" Evidence that protons are the primary particles of the hard component," by T. H. Johnson (*pp.* 208–210).—This suggestion is strongly supported although complete confirmation cannot yet be claimed.

" Recent studies at high elevations," by S. A. Korff (*pp.* 211–221).—Counter technique forms the basis of these observations. Unmanned balloon flights showed no detectable diurnal variation in the cosmic rays at elevations greater than 0·5 m. of water equivalent. Flights made with neutron counters filled with BF_3 showed that the neutron intensity increased rapidly with the elevation, the rate of increase being faster than that of the total intensity of the cosmic radiation and approximately equal to that of the large bursts. A production cross-section of 10^{-25} cm^2. is computed for neutron production by cosmic radiation in the atmosphere.

" Specific ionization of high-speed particles," by R. B. Brode (*pp.* 222–229).—The specific ionisation, together with the momentum ($H\rho$) allows the mass of the particle to be assigned. A consistent picture of the sea-level cosmic radiation is obtained if one assumes that all particles with $H\rho < 10^5$ are electrons, particles with $H\rho$ between 10^5 and 10^6 are a mixture of electrons and mesotrons, while those with $H\rho > 10^6$ are entirely mesotrons.

" Nature of cosmic rays below ground," by V. C. Wilson (*pp.* 230–231).—The author states that cosmic rays may be divided into two groups, one component having a maximum range of about 400 m. and the other possessing a much greater penetrating power. Various suggestions concerning the nature of the rays are examined but no definite conclusion can at present be reached.

" Analysis of deep rays," by P. Auger and T. Grivet (*pp.* 232–234).—Several experimental results on the deep rays, emphasizing their rapid filtration with depth are presented.

" Energy distribution and positive excess of mesotrons," by H. Jones (*pp.* 235–238).—This paper describes experiments made with a vertical cloud chamber at sea-level. For an energy range of $0{\cdot}2 \times 10^9$ eV to 10^{10} eV, an excess of 29% of positive over negative mesotrons is found.

" Determination of the energy spectrum of primary cosmic rays," by M. S. Vallarta (*pp.* 239–240).—An experiment is suggested and it is indicated that the apparatus for the experiment is in process of construction.

PART IV. PRODUCTION OF SECONDARY RADIATION.

" Theory of explosion showers in cosmic rays," by W. Heisenberg (*p.* 241).—The implications of mesotron theory are discussed and its possible bearing on the problems of the measurement of position and of the distance, is indicated.

" Showers produced by penetrating rays and allied phenomena," by W. F. G. Swann (*pp.* 242–254).—The first part of this paper describes an apparatus of counters and electroscopes used to examine shower production, together with the results obtained. The second part presents certain considerations pertaining to cosmic-ray phenomena in the stratosphere.

" Behaviour of high-energy electrons in the cosmic radiation," by C. G. Montgomery and D. D. Montgomery (*pp.* 255–266).—It is maintained that nuclear impact of electrons, themselves produced by mesotron disintegration, is adequate to account for above half the large bursts or Hofmann *Stösse*. The remaining bursts are likewise attributed to photons or electrons formed in the cascade process. Showers of heavily ionizing particles are produced by electrons and photons in the same energy range as those producing Hofmann *Stösse* but the two phenomena are otherwise distinct.

" Burst frequency as a function of energy," by M. Schein and P. S. Gill (*pp.* 267–276).—The size-frequency distribution of bursts obtained from analyses of records made by Carnegie model C cosmic-ray meters, shielded by 12 cm. of Pb, stationed at different places, indicates that at least the greater part of the burst-producing radiation at sea-level consists of penetrating ionising rays—presumably mesotrons. Some of the largest bursts, particularly at high altitudes, appear to be created by photons or electrons of energies greater than 10^{11} eV.

" Some recent experiments on cosmic rays," by P. M. S. Blackett and B. Rossi (*pp.* 277–281).—The authors state that (*a*) in 463 electronic showers, apart from two very doubtful cases, no showers of mesotrons were observed, (*b*) out of 200 showers, no cases occurred where showers emerged from a plate without any track of the primary cause, and (*c*) in 500 traversals of a plate by mesotrons, no single ionizing particles were observed to start from the plate. They conclude that the above experiments give no evidence that processes other than cascade showers occur or that any non-ionizing particles other than photons are present in the cosmic radiation.

" Narrow cosmic-ray showers," by W. Bothe (*pp.* 282–287).—Experiments are described which show that particles in such showers are of penetrating type and are interpreted as medium and low energy mesotrons. The number of particles in the showers is only about two. The results may be explained on the assumption that secondary mesotrons of medium

or low energy are produced by fast mesotrons of the hard cosmic-ray component.

"Extensive cosmic-ray showers," by P. Auger, P. Ehrenfest, R. Maze, J. Daudin, A. Fréon and Robley (*pp.* 288–291).—The conclusion is drawn that particles of energies up to 10^{15} eV are present in cosmic rays and that it is impossible that such energetic particles could result from a single process but rather that such energies are built up in electric fields of astronomical extension.

"Mesotron production in the atmosphere," by M. Schein and V. C. Wilson (*pp.* 292–295).—An experimental test is described, using counters in an aeroplane up to 25 000 ft. A cross-section for the production of mesotrons by photons is obtained which is at least in rough agreement with theory.

"Disintegration of mesotrons," by B. Rossi (*pp.* 296–303).—The variation of the hard cosmic-ray component with zenith angle and the temperature effect suggest that the cosmic mesotrons decay with a lifetime of about 3×10^{-6} sec. There is no evidence, however, that the mesotrons which stop, actually disintegrate into an electron and a neutrino. F. C. C.

742. Experimental test of Schremp's theory of cosmic-ray fine structure. H. S. Ribner. *Phys. Rev.*, **56,** *pp.* 1069–1073, *Dec.* 1, 1939.—From a consideration of geomagnetic and absorptive effects upon the energy spectra of primary cosmic rays, Schremp some years ago inferred the existence of an anomalous directional intensity pattern in the sky, the analysis of which might be expected to yield detailed information concerning the identity of the primary cosmic rays, their energy spectra at infinity, and their interaction with absorbing matter. An east-west directional intensity survey has recently been carried out at Washington University, St. Louis, to test these predictions with apparatus of high angular resolution. In the curve of directional intensity *vs.* zenith angle z, the present results indicate the existence of symmetrical prominences at $z = \pm 20°$ and further suggest that other symmetrically disposed prominences may exist in the neighbourhood of $z = \pm 10°$ and $z = \pm 40°$. This symmetry, in the light of the theory, carries implications concerning the character of the primary cosmic rays. [See preceding Abstract (*p.* 197).] Author.

743. Solar influences on cosmic-ray intensity at high elevations. S. A. Korff. *Frank. Inst., J.*, **229,** *pp.* 21–27, *Jan.*, 1940.—Instrument-carrying balloon flights using the radio-cosmic-ray technique have been made during the day and the night, to investigate the amount of the diurnal variation at high altitudes. It was found that the effect, if any, is smaller than the experimental error of 2%, and is estimated to be about 1·5% of the radiation at these levels. This permits a definite upper limit to be set to any contribution of solar origin to the ionization at levels up to 0·3 m. of water equivalent below the top of the atmosphere, which could be produced by photons in that spectral region to which mass-absorption laws apply, namely X-radiation. The magnitude of the effect is in agreement with the view advanced by Vallarta, that a magnetic field on the sun would produce a small diurnal change in the intensity of the softer portion of the cosmic-ray intensity. Author.

744. Mesons and absorption of cosmic radiation in atmosphere. W. Kolhörster and I. Matthes. *Phys. Zeits.*, **40,** *pp.* 617–619, *Oct.* 1, 1939.—Assuming the experimentally observed decrease of cosmic-ray intensity with decreasing altitude to be due to absorption and decay of

the mesons, a constant value for the decay-coefficient is obtained in the range from 2·6 to 6·2 km. altitude, corresponding to a mean free path of the mesons of $5{\cdot}75 \pm 0{\cdot}19$ km. For lower altitudes, however, there is a sharp decrease in the value of the decay-coefficient thus defined which is considered to be due most probably to some secondary radiation of great intensity setting in at these heights. L. E. F.

745. Penetration of thick layers of Pb by cosmic radiation. I. Matthes. *Ann. d. Physik*, **36,** 5, *pp.* 413–435, *Nov.*, 1939.—Triple and quadruple coincidence experiments were carried out with a total of 90 cm. Pb interposed between the counters. The results can be interpreted in 3 ways: (1) about 37% of the hardest component of cosmic radiation (penetrating through 90 cm. Pb) consists of a mixture of protons and neutrons; (2) showers of very great penetration, extremely small angular aperture, and containing on the average $\leqq 2{\cdot}2$ ionizing particles occur with a considerable frequency; (3) plural scattering of mesons in thick Pb-absorbers is not negligible. The last interpretation is considered to be the most likely. L. E. F.

746. Fluctuations of hard component of cosmic radiation. E. Regener and W. Rau. *Naturwiss.*, **27,** *pp.* 803–805, *Dec.* 1, 1939.—Ionization measurements of cosmic-ray intensity under 40 m. of water, carried on for 14 months in Lake Constance, reveal a 12-hourly period of about 0·2% amplitude. The effect is probably due to atmospheric oscillations which, according to recent ideas, attain considerable amplitudes in the heights in which the mesons are created. L. E. F.

747. Changes of intensity and composition of cosmic rays with magnetic latitude. P. Auger, R. Grégoire, R. Maze and B. Goldschmidt. *Comptes Rendus*, **209,** *pp.* 794–797, *Nov.* 27, 1939.—It was shown by Auger and Leprince-Ringuet in the course of measurements made in 1934 between the geographical latitudes 40°N. and 38°S. that the number of cosmic corpuscles striking 1 unit of horizontal surface in unit time underwent the equatorial lowering discovered by Clay without change of composition in the radiation, the hard group and the soft group varying sensibly in the same way. This result was tested in the course of a voyage from Marseilles to Tahiti by Panama in the latter part of 1939. Very great constancy was shown in the composition of the cosmic radiation as to the relative proportion of mesotrons and electrons. For the showers the results show less regularity than is the case with solitary rays. The results as regards the relative intensity of the hard and soft groups favour the hypothesis of the spontaneous decomposition of the mesotrons. The electrons of the soft group present at sea-level appear to originate almost entirely from the decomposition of the mesotrons and their secondaries. The variation of the showers is only about 1/3 of that of the isolated particles. J. J. S.

See also Abstracts 719, 844, and

306B. Cosmic rays. P. M. S. Blackett.

332B. Spectral distribution of radiation from lamps of various types. B. T. Barnes, W. E. Forsythe and W. J. Karash.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTER-GLOW.

748. Fluorescence of diacetyl. G. M. Almy, H. Q. Fuller and G. D. Kinzer. *J. Chem. Phys.*, **8,** *pp.* 37–45, *Jan.*, 1940.—The observed properties of the fluorescence of diacetyl and acetone are compatible with the assumption that the fluorescing molecule is, in both cases, diacetyl.

Following the excitation of diacetyl there must be a redistribution of vibrational energy in such a way that the amounts allotted to the modes of vibration important in the fluorescence are not very dependent upon the wavelength of exciting light or the numbers of collisions before emission. The lifetime of the excited state is about 10^{-5} sec., as estimated on the assumption that the quenching process with oxygen requires a collision diameter of 3×10^{-8} cm. This is a reasonable figure for a chemical reaction, which, it is inferred, takes place because the oxygen is consumed. A lifetime of the same order of magnitude was obtained in an experiment on the diffusion of the excited molecules into a shadow. This experiment also makes very improbable the hypothesis that the apparent fluorescence of diacetyl and acetone is a recombination spectrum. The apparent fluorescence of acetone is probably light emitted by diacetyl molecules formed from acetyl radicals and excited in collisions with acetone or recombining radicals. AUTHORS.

749. Total light output from phosphors with several activators. P. BRAUER. *Ann. d. Physik*, **36**, 2, *pp.* 97–104, *Sept.*, 1939.—Methods are described for separating the light output due to Sm and to Pr respectively when both of these activators are simultaneously operating in the same host, e.g. CaO. Strong suppression of the Sm light is observed in the presence of Pr. Spectroscopic observations on the fluorescent part (*momentanleucht*) of the emission shows that the Sm is still excited and that somehow its emission is quenched by the presence of the Pr. The effect is greater with increasing concentration and is attributed to some interaction effect of neighbouring Sm and Pr atoms. J. E.

INTERFERENCE, DIFFRACTION AND SCATTERING.

750. Diffraction of light by a thin metallic half-plane. N. ANANTHANARAYANAN. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 477–490, *Dec.*, 1939.—A method has been devised for preparing uniform metallic films having edges of razor-like sharpness. Some novel features, which are not seen either in the case of an opaque screen bounded by a straight edge or in that of a transparent lamina, are observed in the Fresnel diffraction patterns with such Ag films, the chief feature being the large number of fringes with high visibility to be found on the darker side of the pattern. The changes taking place with increasing thickness of the film and also with the wavelength of the incident light are described. It has been found that the minimum having the best visibility marches into the "shadow" to a fringe of higher order as the thickness of the film is increased. The problem has been treated theoretically and intensity curves for the patterns for four films of different thicknesses have been drawn. The results are in agreement with experiment. By considering the interferences between the incident or the transmitted plane wave and the diffracted cylindrical wave diverging from the edge, the general features of the phenomenon can be readily interpreted in much the same way as in the case of an opaque screen. AUTHOR.

751. Theory of light scattering. S. PARTHASARATHY. *Phil. Mag.*, **29**, *pp.* 148–153, *Feb.*, 1940.—It is shown in this paper that the scattering of light observed by R. S. Krishnan in binary liquid mixtures is purely molecular, and that no scattering arises from clusters, if any, at the critical solution temperature. Neither is the critical solution mixture emulsoidal. At any rate, his optical method of using incident horizontally polarized

light is vitiated by grave experimental errors which have not been taken into account. His anomalous results have been explained by taking into consideration the error due to the convergence of the lens used for focusing the incident light. No new theory, therefore, as, for example, that of Frenkel or of Gans or of Mueller, appears to be necessary to explain the results. AUTHOR.

See also Abstracts 787, 841.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

752. High temperature photolysis of acetaldehyde. D. C. GRAHAME AND G. K. ROLLEFSON. *J. Chem. Phys.*, **8**, *pp.* 98–105, *Jan.*, 1940.—A detailed investigation of the high temperature photolysis of acetaldehyde vapour has given results differing in certain details from those of previous investigators. The heat of activation found for the over-all reaction ($8{\cdot}6 \pm 0{\cdot}3$ kg. cal.) leads with one assumption to a value of 75 kg. cal. for the energy of the C–C bond in acetaldehyde. The reaction between methyl radicals is rather accurately bimolecular. Values are given for the relative quantum efficiencies for the production of free radicals in acetone and acetaldehyde at elevated temperatures at two wavelengths. [See Abstract 4015 (1939).] AUTHORS.

753. Photochemistry of diiodoacetylene and tetraiodoethylene. J. W. TAMBLYN AND G. S. FORBES. *Am. Chem. Soc., J.*, **62**, *pp.* 99–104, *Jan.*, 1940.—A quantitative study of the photoiodination rate of C_2I_2 in hexane, with careful exclusion of O_2, in red and in blue light, shows that a chain reaction occurs, C_2I_4 being formed quantitatively. The equation $-d[I_2]/dt = k_\lambda L_0^{\varkappa_\lambda}[I_2][C_2I_2]/\{a_\lambda + b_\lambda[C_2I_2]\}$ generalizes the data obtained. k_λ, $\varkappa_\lambda$, a_λ, and b_λ must be evaluated separately for each spectral interval considered. The reaction mechanism varies with the wavelength of the light employed. L_0 is 0·4 for blue light, 0·6–0·7 for orange light, and 0·8 for red light. Integration gives a specific rate constant, valid at any given wavelength if proper values of the four constants are supplied. C_2I_4 in hexane was photolysed in u.v. light, 254 mμ (oxygen removed). At first 1 molecule of free I_2 appears for each C_2I_4 molecule that disappears, and the quantum yield is 0·8. In the late stages an unidentified product was observed. A qualitative study of the photolysis of C_2I_4 in hexane indicates complications due to the formation of polymeric substances. N. M. B.

754. Transfer of excitation energy from uranium ions in solution. A. H. CARTER AND J. WEISS. *Roy. Soc., Proc. A*, **174**, *pp.* 351–370, *Feb.* 15, 1940.—The transfer of electronic excitation energy in solution has been investigated in the case of the photosensitized decomposition of oxalic acid by uranium ions, and more detailed information about the mechanism of the energy transfer has been obtained by studying the reaction in the presence of substances (I^-, Br^-) which can act as quenchers of the uranium fluorescence. New experimental facts are presented which cannot be explained by any of the previously advanced theories. In particular, widely different relative amounts of the products of decomposition (CO, CO_2, HCOOH) have been observed with varying concentration of the quenching substances and H ions present in the solution. A theory is discussed based on the electron transfer process between excited uranium ions and oxalate ions. The observed complex formation between the reacting ions is interpreted on the basis of a quantum mechanical resonance

in the elementary process of quenching. In connection with the above investigation the quenching process of the uranium fluorescence by I^- has been investigated and the elementary processes involved have been studied experimentally and discussed on a similar theoretical basis.

AUTHORS.

755. Mechanism of development. Part II. T. H. JAMES. *Kodak Research Lab. Comm. No.* 724. *J. Phys. Chem.*, **44,** *pp.* 42–57, *Jan.*, 1940.—The rate of development by hydroquinone in the absence of Na_2SO_3 and O_2 varies as the square root of the hydroquinone concentration and the first power of the OH-ion concentration in the *p*H range 8·0 to 8·9 The rates measured approximate the average rates of development of the individual AgBr grain. The addition of quinone to the developer results in an increase in the development rate, which is due to an effect, presumably of a decomposition product of the quinone, upon the double-layer electric barrier. The quinone likewise attacks the development centres, resulting in a decrease in the number of developed grains for a given exposure. The divalent ion is the active developing agent. Reduction occurs heterogeneously at the silver-silver halide interface. Comparative rates are given for the development reaction, autoxidation, and the silver-catalyzed reaction of Ag ion with a series of substituted hydroquinones. [For Part I see Abstract 3658 (1939).] AUTHOR.

756. Number of quanta required to form the photographic latent image. E. W. H. SELWYN. *J.O.S.A.*, **29,** *p.* 518, *Dec.*, 1939.—A note supplementing earlier work [see Abstract 4023 (1939)]. Discrepancies found in the experimental work lead to the conclusion that there must be some cases where geometrically identical grains of a given emulsion are not all of equal sensitivity. A. H.

757. Theory of photographic latent-image formation. J. H. WEBB. *J. of Applied Physics*, **11,** *pp.* 18–34, *Jan.*, 1940.—An outline of the important developments during the past 25 years and a description of the most recent theories on the subject.

PHOTOMETRY.

See Abstract 709 and
333B. Physical photometry. J. Voogd.

POLARIZATION.

758. Influence of rotational hindering and inner field anisotropy on the polarization of liquids. A. PETERLIN AND H. A. STUART. *Zeits. f. Physik*, **113,** 11–12, *pp.* 663–696, 1939.—This paper is a contribution to the molecular theory of polarization and of artificial double refraction in liquids and solutions, and considers the simultaneous influence of freedom of rotation and of inner field anisotropy upon them. The momentary preferential axes of molecular orientation and those coincident symmetrical axes due to the anisotropy of the inner field, are both given by the structure of the immediate neighbourhood of the molecule under consideration which is not influenced by adjacent external fields. The proper association, which is characterized by pronounced union at one or several preferred neighbours, and which requires the introduction of variable molecules (double or higher numbers) into the theoretical treatment, is not permitted by the introduction of a hindering potential, e.g. of an inner anisotropic field. The comparisons of the theory now developed with experiment shows that this preferential reciprocal effect plays a greater rôle than had

formerly been assumed, and in only a limited number of cases can satisfactory relationships be derived. A theory of liquids must, however, take into consideration other circumstances such as the deformation of the electronic shells of molecules through dense packing and also the periodic fluctuations of the neighbouring environment. H. H. Ho.

REFLECTION, REFRACTION AND DISPERSION.

See Abstracts 591, 627, 794, 825, 826.

SPECTROSCOPY.

759. Spectrographic determination of small concentrations of Be in Mg alloys. A. Beerwald. *Zeits. f. Elektrochem.*, **45**, *pp.* 833–835, *Nov.*, 1939.—The spectro-analytical method of Scheibe and Rivas has been applied to the determination of small amounts of Be in Mg alloys. Standard electrodes were prepared by sparking two spectrally-pure C rods and cooling them by treatment with a known small volume of a standard HCl solution of Mg, Al, and Be. Electrodes were similarly prepared using solutions of two different alloys in HCl. The arc spectra were then obtained, using identical conditions, exposure, separation of electrodes, etc. Visual comparison of the intensities of the Be doublet (3 131·06 and 3 130·42 Å allowed the concentration of Be in the alloys to be estimated, and the results are in good agreement with those obtained by photometric measurements. W. R. A.

760. Infra-red arc spectrum of germanium. C. C. Kiess. *Bureau of Standards, J. of Research*, **24**, *pp.* 1–5, *Jan.*, 1940.—For theoretical reasons it is known that a portion of the arc spectrum of Ge must lie in the infra-red. The more intense lines in this region have now been recorded on the specially sensitized plates of the Eastman series with the grating spectrographs of the National Bureau of Standards. Most of the new lines have been classified as combinations between the previously known $^3P^\circ$ and $^1P^\circ$ terms of the $5s$ configuration with new triplet and singlet terms of the $5p$ configuration. The yellow lines observed by Lunt in spark and discharge tube sources are found to be lines of Ge I and, in analogy with similar lines of C I and Si I, probably owe their origin to the $5s$–$6p$ transition. Author.

761. Mg-like spectra of Cl, K, Ca and Sc. W. L. Parker and L. W. Phillips. *Phys. Rev.*, **57**, *pp.* 140–141, *Jan.* 15, 1940.—About eighty lines belonging to the triplet systems of the Mg-like ions, Cl VI, K VIII, Ca IX, and Sc X, have been identified. Term values for each ion are reported with respect to the $3s3p\ ^3P_0$ level. Authors.

762. Intensity of He lines in absorption. H. C. Burger and H. P. van Cittert. *Physica*, **7**, *pp.* 13–16, *Jan.*, 1940. *In English.*—The ratio of the absorption coefficients of two He lines is measured, and is found in satisfactory accordance with Hylleraas's theory. [See Abstract 4048 (1937).] Authors.

763. Determinations of Rydberg constants, e/m, and fine structures of Hα and Dα with a reflection echelon. J. W. Drinkwater, O. Richardson and W. E. Williams. *Roy. Soc., Proc. A*, **174**, *pp.* 164–188, *Feb.* 1, 1940.—Using a 40-plate reflection echelon *in vacuo* a study is made of the fine structures of Hα and Dα. It is concluded that no real evidence has yet been obtained to show that the fine structures depart substantially from the values calculated from Dirac's equations and that discrepancies which appear to support the suggestion of a perturbation of the $2^2S_{\frac{1}{2}}$ level are

caused by molecular lines. The main numerical results obtained are given in the table. In a note added in proof it is stated that Birge suggests that

H_α	$15\,233{\cdot}067_0$ cm^{-1}.	*Modified Values*
D_α	$15\,237{\cdot}11_2$ cm^{-1}.	
R_H	$109\,677{\cdot}58_3$ cm^{-1}.	
R_D	$109\,707{\cdot}42_1$ cm^{-1}.	
R_∞	$109\,737{\cdot}27_2$ cm.$^{-1}$	109 737·26
e/m	$(1{\cdot}7591 \pm 0{\cdot}0004) \times 10^7$ e.m.u./g.	1·7590
M_H/m	$1\,837{\cdot}4_8$	$1\,837{\cdot}7_2$

the accepted value of q (defined by international ampere $= q$ absolute ampere) requires modification; this involves changes in some of the constants. These changed values are given in the table under the heading "modified values." A. H.

764. Band spectrum of InH. B. Grundström. *Zeits. f. Physik*, **113**, 11–12, *pp.* 721–729, 1939.—The results of the analysis of two band systems $^1\Pi$–$^1\Sigma$ and $^1\Sigma^*$–$^1\Sigma$ in the InH spectrum are given in the form of term sequences. The bands lie in the region 5 650–7 250 Å. The 0, 0 band in the $^1\Pi$–$^1\Sigma$ has the wave number 16 905·00 cm^{-1}. while the corresponding band in the $^1\Sigma^*$–$^1\Sigma$ system is given by $\nu_0 = 16\,259{\cdot}64$ cm^{-1}. The bands show perturbations and predissociation. T_c becomes unstable for lower term values than T_d in the predissociation of the $^1\Pi$-term, i.e. the predissociation of InH shows a different behaviour from MgH. L. K.

765. Absorption of water at different temperatures from 2·5 to 7·5 μ. J. J. Fox and A. E. Martin. *Roy. Soc., Proc. A*, **174**, *pp.* 234–262, *Feb.* 1, 1940.—The authors investigated the infra-red absorption of ice at − 9°C., water at + 3°C. and + 70°C., and water dissolved in CCl_4 from 2·5 to 7·5 μ with a grating spectrometer of high resolution. The 3 μ band shifts to higher frequencies with increasing temperature while the 6 μ and 4·7 μ bands move in the opposite direction. The reasons for this behaviour are hydrogen bonds between neighbouring H_2O molecules which decrease the OH valence forces and increase the angular forces. The hydrogen bonds are strongest in ice and decrease with rising temperature. The intensity of the valence vibrations shows a very marked increase with growing association of the molecules. Two valence frequencies at 3 705 and 3 614 cm^{-1}. are found for water dissolved in CCl_4, 40–50 cm^{-1}. below the corresponding value for H_2O vapour. The 4·7 μ band is ascribed to the combination frequency between the deformation frequency and the frequency of hindered rotation at approximately 500 cm^{-1}. which latter frequency diminishes rapidly with rising temperature and disappears altogether for the vapour in accordance with the observations on the 4·7 μ band. A brief discussion is given of the structure of liquid water and its effects on the infra-red spectrum. L. K.

766. Infra-red O—H band and association. J. Errera, R. Gaspart and H. Sack. *J. Chem. Phys.*, **8**, *pp.* 63–71, *Jan.*, 1940.—The vibration of the O—H group in alcohol and HDO has been studied in the 3 μ region for solutions and ternary mixtures at different concentrations and tem-

peratures. The experimental results are discussed in terms of association and addition-compound formation. AUTHORS.

767. Application of new method of analysis to molecular spectra. Relationship between molecular frequencies in gaseous and liquid states. H. DESLANDRES. *Comptes Rendus*, **209**, *pp.* 865–869, *Dec.* 11, 1939.—The work described in previous papers [see Abstract 4594 (1939)] is now extended to the analysis of frequencies of SiH_4, S_2, NH_3, HCl, DCl, C_2H_2 and C_2D_2. An attempt is made to establish a simple numerical relationship between corresponding frequencies in gaseous and liquid states of these molecules, of the type already indicated in the cases of PH_3 and PD_3. C. B. A.

768. New resonance points in absorption spectra of thin metal layers. H. WOLTER. *Zeits. f. Physik*, **113**, 9–10, *pp.* 547–553, 1939.—Consideration of the properties of thin Au and Ag layers shows that their optical anomalies cannot be satisfactorily explained by any theory based primarily on variation of the number and the mean free path of the free electrons. On the contrary, starting from the dispersion equation selected by Planck and by Kindinger and Koller, it is shown that thin metal layers, in contrast to massive metal, possess bound electrons with natural frequencies in the long-wave part of the visible spectrum and in the infra-red. The number of electrons per atom concerned with these new natural frequencies is calculated for Ag layers of thickness from 1 to 7 mμ and found to vary from 0·2 to 0·74. A. W.

769. Near infra-red absorption spectra of sugars. E. S. BARR AND C. H. CHRISMAN, JR. *J. Chem. Phys.*, **8**, *pp.* 51–55, *Jan.*, 1940.—The infra-red absorption spectra of aqueous solutions of 9 monosaccharides and 4 disaccharides have been observed in the region between 1·7 and 4·6μ. A special technique of evaporation was used in the preparation of samples, so as to minimize the effect of the solvent upon the transmission curves. It was found that all 13 materials gave very similar spectra ; band locations were very nearly identical, although there was some degree of variation in intensities. Bands not previously reported were found at 2·16 and 2·35μ, and the intense absorption in the region of 3·3μ was partially resolved into component bands. AUTHORS.

770. Spectroscopic measurements of gaseous CN. Part I. Dissociation in electric discharge. J. U. WHITE. *J. Chem. Phys.*, **8**, *pp.* 79–90, *Jan.*, 1940.—Free CN radicals in the gaseous state are formed in the electric discharge through cyanogen. By the use of a very intense low-pressure spark as a background the 0,0 and 1,1 bands of the $^2\Sigma \rightarrow {}^2\Sigma$ transition of CN have been observed in absorption at short intervals of time after the end of this discharge. The intensities of the lines of the bands were measured by means of microphotometer traces of the spectra and of the characteristic curve of the photographic plate. They were corrected for the incomplete resolution of the spectrograph. Relative concentrations of CN were calculated from the sums of the intensities of the lines. The rate of disappearance of CN after the end of the discharge was studied and found to be the same over a large range of pressure and dilution with argon. A mechanism is proposed to account for this. In all the disappearance was exponential with a mean half-life of 11 m.sec. The half-life of the first excited vibration state was 3 m.sec., during which time about 10 000 collisions occurred. By dilution of the cyanogen in the discharge tube with argon until the CN bands were no longer visible the partial pressure of CN could be calculated on the assumption that near this point

all the cyanogen present was observed in the form of CN. The minimum detectable pressure of CN was of the order of 2×10^{-6} mm. The absolute f value of the $^2\Sigma \rightarrow {}^2\Sigma$ transition is 0·026 (± 0·006). By using the corresponding absolute absorption coefficient and the observed temperature distribution in a carbon arc the partial pressure of CN present in an arc is calculated to be of the order of 10 mm. AUTHOR.

771. U.v. absorption spectra of some derivatives of 1,2-benzanthracene. R. N. JONES. *Am. Chem. Soc., J.*, **62,** *pp.* 148–152, *Jan.*, 1940.—Data are tabulated for the position of maxima and corresponding intensities in the u.v. absorption spectra of 1,2-benzanthracene and of 10 mono- and di-methyl derivatives. The spectra are closely similar in shape and intensity. Considerable variation is observed in the bathochromic shift of the position of the maximum of the most intense band, and this appears to show some correlation with the variation in the carcinogenic activity of the hydrocarbons. The spectrum of 1′,9-methylene-1,2-benzanthracene differs markedly from that of the other derivations, and this is possibly due to stearic strain in the molecule. N. M. B.

772. Rotational analysis of first negative band spectrum of oxygen. Part II. T. E. NEVIN. *Roy. Soc., Proc. A*, **174,** *pp.* 371–378, *Feb.* 15, 1940. —In continuation of previous work [see Abstract 713 (1939)] the (0,2) and (2,0) bands of the first negative system of oxygen due to the transition $^4\Sigma_g^- \rightarrow {}^4\Pi_u$ have been photographed in the second order of a 21 ft. grating and an analysis of the bands is given. The $^4\Pi$ level $v'' = 2$ exhibits the same structure as the previously analysed levels $v'' = 0$ and 1 failing to agree with the theoretical structure predicted by Brandt and Budó. An empirical formula is given which represents the observed structure reasonably well. A complete table of the molecular constants of 5 bands of the system is given. AUTHOR.

773. Line breadth of HCl bands. E. LINDHOLM. *Zeits. f. Physik*, **113,** 9–10, *pp.* 596–606, 1939.—Measurements of breadths of lines of HCl bands at 9 152 Å show that the P-lines are rather broader than the R-lines. The breadths are calculated theoretically, an approximate treatment of the dispersion and induction effects being taken into account. It is found that the difference between the P and R branches arises from the difference between the moments of inertia in the lower and upper vibrational states. A comparison is made with older measurements for the longer wavelength rotation-vibration bands. The breadths of the pure rotation lines are calculated, agreement being obtained between the quantum mechanical intensities of the rotation lines and Czerny's measurements. [See also Abstract 2899 (1938).] C. B. A.

774. Shift of intensity in N_2^+ bands excited in He and Ne. T. TAKAMINE, T. SUGA AND Y. TANAKA. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* **939,** *pp.* 437–448, *Nov.*, 1939.—The second negative band of ionized nitrogen $N_2^+\{B'(^2\Sigma_u) \; X'(^2\Sigma_g^+)\}$ shows a distinct shift in its intensity according as He or Ne is used for the main gas in the discharge tube to which a small amount of N_2 is added. A tentative interpretation to account for the phenomenon is stated. AUTHORS.

775. Coriolis perturbations in spectra of silane and germane. G. M. MURPHY. *J. Chem. Phys.*, **8,** *pp.* 71–78, *Jan.*, 1940.—A Coriolis perturbation on the rotational structure of the fundamental frequency, ν_4 has been computed for silane and germane. Matrix elements of the Coriolis operator, A for the lines P(9), P(10), and Q(10) have also been obtained. The envelope of the resulting absorption curve has been

compared with the experimental curve and good agreement found. The most striking difference in the two spectra is that in the case of silane, the Q branch degrades toward lower frequencies and in germane, towards higher frequencies. This is shown to be due to the relative position of the infra-red inactive frequency, ν_2 to which the perturbation is due.

AUTHOR.

776. Absorption spectra of $InCl_2$, $InBr_2$, InI_2 and $GaCl_2$ in the Schumann region. M. WEHRLI AND W. WENK. *Helv. Phys. Acta*, **12**, 7, *pp.* 559–560, 1939. *In German.*—The wavelengths of the maximum absorptions and the temperatures at which they are most pronounced are summarized in a table. It is seen that each substance shows 4 continua whose maxima shift towards the red from the chloride to iodide. A similar relationship has been found by Wieland in the mercury halides [see Abstract 4956 (1932)]. That the 4 continua shown belong to the triatomic halides or their polymers has been confirmed by experiments with InCl and $InCl_3$. The first shows a very broad continuum besides K_b and K_d very faintly, the latter disappearing in presence of excess In. $InCl_3$ shows a broad faint continuum and K_b, K_c and K_d so faintly that they cannot be due to $InCl_3$. In addition to the continua shown on the table $InCl_2$ shows at 300° C diffuse bands at 1 970, 2 002, 2 042 ; $InBr_2$ shows at 230° C bands at 1 648, 1 655, 1 671 and 1 852, 1 859 and 1 864. The carriers of these bands cannot yet be determined. Fluorescence investigations on InCl and InBr indicate a photochemical decomposition into an unexcited halogen atom and an excited In atom (^2S state). J. E.

777. Continuous absorptions of N_2O. H. SPONER AND L. G. BONNER. *J. Chem. Phys.*, **8**, *pp.* 33–37, *Jan.*, 1940.—The absorption of N_2O in the long wavelength region of the near u.v. has been reinvestigated with an absorption tube 105 ft. in length. The well-known absorption in this region has been extended and its resolution into several components is discussed. A few remarks are added about other continuous absorption regions in connection with different dissociation reactions of N_2O. AUTHORS.

778. Experimental investigation of light emission processes. Line emission and absorption spectra of crystals of Eu salts. O. DEUTSCHBEIN. *Ann. d. Physik*, **36**, 2, *pp.* 183–188, *Sept.*, 1939—The emission and absorption spectra of various Eu salts, and in particular the hexagonal crystals of the bromate, are examined when irradiated with u.v. light. The nature of the polarization and the variation of intensity with the direction of the crystal axis are determined. Certain of the lines are identified as electric dipole and others as magnetic dipole radiation. The selection rules associated with these radiations are $\Delta J = \pm 1$ for the magnetic and $\Delta J = \pm 2$ for the electric dipole radiations. Results for other Eu salts are more complicated but lead to similar assumptions about the selection rules. W. E. D.

779. Quenching and vibrational energy transfer in fluorescence spectrum of S_2. E. DURAND. *J. Chem. Phys.*, **8**, *pp.* 46–50, *Jan.*, 1940.—The u.v. fluorescence of S_2 was excited by the strong Mg spark lines λλ2 928 and 2 937 Å. A typical Wood resonance progression was observed with pure S_2 only in the vessel, but the addition of a few mm. of any of the rare gases caused changes in the fluorescence due to quenching and to the transfer of vibrational and rotational energy. The yields per collision for quenching and for vibrational transfer are of the order of magnitude of unity, and both show the same dependence on the atomic weight of the rare gas added, with a minimum in the vicinity of A or Kr.

Comparisons are made with the results obtained by other methods. Quenching occurs by the addition of two quanta of vibrational energy to the S_2, followed by disruption due to predissociation. AUTHOR.

780. Zeeman effects in complex spectra at fields up to 100 000 gauss. G. R. HARRISON AND F. BITTER. *Phys. Rev.*, **57**, *pp.* 15–20, *Jan.* 1, 1940.—A newly constructed electromagnet of the Bitter type has been arranged to give fields up to 100 000 gauss, uniform to 1% over a volume of 25 cm^3. A special type of horizontal arc, with electrodes of salts compressed in silver powder, is operated at 4 A and furnishes light transversely to the field to three grating spectrographs, which can be used to cover the range 2000 to 8000 Å in a single exposure. Plane-polarized components of the light are separated with a 2-in. quartz Rochon prism, and exposures of 5 to 30 min. give dense spectrograms at resolutions of 100 000 and greater. Plates in the u.v. region have been obtained for Ce, Cb, Er, Eu, Gd, Fe, Nd, Pr, Rh, Ru, Th, W and Yb. On most of the plates lines of the second and third spectra are more in evidence than those of the first, and air lines are prominent. Typical portions of a rhodium plate at 90 500 and 70 000 gauss are shown, and data are given for a number of Ce, Rh and Ru lines. AUTHORS.

781. Experimental refutation of statistical conception of Bohr atomic model. J. STARK. *Phys. Zeits.*, **40**, *pp.* 590–591, *Sept.* 15, 1939.—Previous work has shown that the red components of the H-lines H_δ may be so weakened by a sufficiently strong field, that they become invisible with respect to the violet. Based on this experimental result, the author argues against the Schrödinger statistical conception of the Bohr atomic model, which is claimed to be inconsistent with physical reality. H. H. Ho.

782. Fine structure of H-lines. J. STARK. *Phys. Zeits.*, **40**, *pp.* 591–592, *Sept.* 15, 1939.—Experimental investigations of the fine structure of H-lines have generally been discussed from the standpoint of the relativity theory. In the present paper, however, the data are considered from the point of view of general spectrum experience and also from the effect produced on the fine structure of H-lines by electrical fields. From analogy with the alkali metals, it is to be expected that every doublet component of the H-lines should consist of 3 components, viz. a principal series and two subsidiary series of lines. From displacements produced by an electric field this conception is now shown to be correct. H. H. Ho.

783. Infra-red and Raman spectra of C_2D_2, C_2DH, and C_2H_2. F. STITT. *J. Chem. Phys.*, **8**, *pp.* 56–59, *Jan.*, 1940.—The infra-red spectra of C_2H_2 and its D isotopes have been studied on a prism spectrometer from 450 to 4000 cm^{-1}. All but 2 of 30 observed bands have been assigned as fundamentals, first and second overtones, and one-one combination or difference bands. Most of the bands of these types which are infra-red active according to the selection rules are either observed or occur in a region where they may be masked by the presence of superimposed bands. [See Abstract 2550 (1939).] AUTHOR.

784. Infra-red and Raman spectra of dimethyl sulphide $(CH_3)_2S$. R. FONTEYNE. *J. Chem. Phys.*, **8**, *pp.* 60–62, *Jan.*, 1940.—The infra-red spectrum of gaseous dimethyl sulphide has been studied from 1·6 to 26μ, as well as the Raman spectrum of the liquid. A tentative vibrational analysis is given. AUTHOR.

See also Abstracts 593, 707, 786, and

217B. Spectral analysis of Al alloys. F. Wolbank.

TRANSMISSION.

785. Ballistic theory of light and principle of constancy of velocity of light. O. Mathias. *Phys. Zeits.*, **40,** *pp.* 443–460, *July* 1, *and pp.* 559–572, *Sept.* 1, 1939.—A historical and critical account is given of the theory that classical kinematics can be applied to the corpuscular theory of the motion of light using the assumption that if $\mathbf{v}$ is the (vectorial) velocity of the light-source relative to an observer, then the velocity of the light emitted is $\mathbf{V} = \mathbf{c} + k\,\mathbf{v}$, $0 \leq k \leq 1$, where $\mathbf{c}$ is the light-velocity relative to the source. This hypothesis must be tested by observations of eclipsing and spectroscopic binaries and de Sitter's objection, viz., that if light partook of the velocity of its source, binaries could show no sharp spectral lines, must be overcome. The work of La Rosa, Zerhellen, Thirring and Bernheimer in this connection is reviewed and discussed. It is concluded finally that if binaries are to show sharp spectral lines then k must satisfy the inequality $k < 0{\cdot}0014$. Again the theory predicts that eclipsing binaries with one dark component should show oscillations of brightness of a type which are not observed. This criterion restricts k to satisfy $k < 0{\cdot}00074$. The conclusion that these small values of k indicate that special relativity ($k = 0$) is correct is, however, not drawn. G. C. McV.

786. Quadratic Doppler effect. G. Otting. *Phys. Zeits.*, **40,** *pp.* 681–687, *Nov.* 15, 1939.—Application of the Lorentz transformation and subsequent series development gives the following formula connecting wavelength displacement with velocity of the light sources: $\Delta\lambda = \lambda_0 \{-(v \cos \delta)/c + v^2/2c^2\}$. Hence, in addition to the ordinary Doppler effect of the first order, there is a small additional displacement towards the red observable as a transverse effect. Measurements with canal rays, using Billing's interference method for the accurate measurement of the Doppler line wavelengths, were found to give results in close agreement with the above formula. A. W.

See also Abstracts **736, 737.**

VISION.

787. Visibility of a thin wire. H. M. Reese. *J.O.S.A.*, **29,** *p.* 519, *Dec.*, 1939.—Using diffraction theory the author calculates the brightness of the centre of the telescope image of a fine dark wire on a bright field, when the aperture of the telescope is such that the image is just imperceptible to the eye. He finds that the value is about 6% less than the brightness of the field. Thus under these conditions the eye can perceive a difference of brightness of about 6% as against 1 to 2% in a modern visual photometer. W. S. S.

788. Hue saturation and lightness of surface colours with chromatic illumination. D. B. Judd. *J.O.S.A.*, **30,** *pp.* 2–32, *Jan.*, 1940.—The visual mechanism of a normal observer is so constructed that objects keep nearly their daylight colours even when the illuminant departs markedly from average daylight. The processes by means of which the observer adapts to the illuminant or discounts most of the effect of a non-daylight illuminant are complicated; they are known to be partly retinal and partly cortical. By taking into account the various fragments of both qualitative and quantitative information to be found in the literature, relations have been formulated by means of which it is possible to compute approximately the hue, saturation, and lightness (tint, value) of a surface colour from the tristimulus specifications of the light reflected from the surface and of the

light reflected from the background against which it is viewed. Preliminary observations of 15 surfaces under each of 5 different illuminants have demonstrated the adequacy of the formulation and have led to an approximate evaluation of the constants appearing in it. More detailed and extensive observations have been carried out in the psychological laboratories of Bryn Mawr College, and these observations have resulted in an improved formulation. AUTHOR.

See also Abstract 842.

X-RAYS.

789. X-ray scattering by an aggregation of particles. R. HOSEMANN. *Zeits. f. Physik*, **113,** 11–12, *pp.* 751–768, 1939.—The author discusses the theory of the scattering of X-rays by a small particle and shows that the distribution of intensity in the central spot is not dependent on whether the particle is a crystal, a micelle, an amorphous conglomerate, etc. It is possible, on the assumption that the particle is an ellipsoid of rotation, to calculate this intensity distribution and conversely from a knowledge of the intensity distribution to calculate the frequency distribution of the particle lengths and thicknesses in a scattering mass of such particles. On the basis of these calculations the author proposes a new method of investigating the submicroscopic structures of substances composed of particles and in a later paper [*ibid.* 114, *p.* 133, 1939] the method is to be applied to the problem of the fine structure of cellulose. J. I.

790. Space-lattice interferences and resonance processes. W. KOSSEL. *Ann. d. Physik*, **36,** 3–4, *pp.* 189–193, *Oct.*, 1939.—The diffraction of X-rays by a crystal lattice is considered to be analogous to a resonance phenomenon. J. T.

791. Indirect excitation of X-ray interferences. E. LAMLA. *Ann. d. Physik*, **36,** 3–4, *pp.* 194–208, *Oct.*, 1939.—Basing his calculations on the dynamical theory of v. Laue, the author shows that when the breadth of the X-ray reflection from a given crystal plane is vanishingly small it may be increased by reflection at another plane. The phenomenon of *Umwegreflexion* [see Abstract 3637 (1937)] is thereby explained. J. T.

792. Surface of propagation of scalar waves in a medium with a lattice structure. E. FUES. *Ann. d. Physik*, **36,** 3–4, *pp.* 209–226, *Oct.*, 1939.—The dynamical theory of diffraction by a lattice permits the conception of a surface of propagation. Observed diffraction phenomena are explained on this basis. J. T.

793. Temperature effect on X-ray interferences at monatomic hexagonal crystals. M. KOHLER. *Ann. d. Physik*, **36,** 3–4, *pp.* 227–238, *Oct.*, 1939.—The Debye-Waller formula for the temperature factor e^{-M} only applies to isotropic matter and such of cubic structure; for M contains a factor $\mu(\bar{h})$, the mean square of displacement in direction $\bar{h}$. In case of hexagonal symmetry this becomes dependent on the angle between the hexagonal axis and the normal on the reflecting plane. $M \sim \sin^2(\mu_{\parallel} \cos^2 \delta + \mu_{\perp} \sin^2 \delta)/\lambda^2$. Expressions for the ratio $\mu_{\parallel}/\mu_{\perp}$ in terms of elastic constants are derived for both, ordinary and very low temperatures. Using reliable empirical values for the elastic constants of Zn and Mg the formulae are evaluated for these elements. The results 2·45 (Zn) and 0·933 (Mg) conform satisfactorily with observations, 2·82 and 0·931 respectively. As was expected the theory only applies to low temperatures. H. O. S.

794. Dispersion theory. G. Molière. *Ann. d. Physik*, **36**, 3–4, *pp.* 265–274, *Oct.*, 1939.—In considering the coherent scattering of X-rays with a view to extending to it v. Laue's theory for the case of visible radiation, the author discusses the relative merits of the two methods of treating the problem, by one of which no difference is made between the exciting field and the field of the scattered radiation, and the other in which it is assumed that the moment induced in each separate atom is conditioned by the external field acting on it. The results of the investigation show that v. Laue's process is more correct while the other is reducible to an approximation to it. It is also concluded that the usual order of approximation of quantum mechanical dispersion theory is insufficient at optical frequencies. For X-rays the Waller dispersion formula is a useful approximation, but in the region of optical frequencies the dispersion theory must be further developed along the lines of the v. Laue process. G. O. B.

795. Diffraction of X-rays by liquid and plastic sulphur. N. S. Gingrich. *J. Chem. Phys.*, **8**, *pp.* 29–32, *Jan.*, 1940.—X-ray diffraction patterns of plastic S at room temperature and of liquid S at several temperatures ranging from 124°C. to 340°C. have been obtained. The position of the main peak in terms of $(\sin\theta)/\lambda$ is 0·140 at 124°C., 0·138 at 147°C., 0·138 at 151°C., 0·139 at 157°C., 0·127 at 166°C., 0·127 at 175°C., 0·125 at 225°C., and 0·120 at 340°C. Atomic distribution curves have been obtained in the cases of plastic S, and of liquid S at 124°C., 166°C., 175°C., 225°C., and 340°C. These curves all appear somewhat similar. The nearest neighbours are found at 2·08 Å for plastic S, and at approximately 2·07 Å for liquid S at all temperatures. The number of nearest neighbours is 2·0 for plastic S, and it is about 1·7 for liquid S. The possibility of using the present information in explaining certain properties of S is discussed. Author.

796. Sensitivity of water and ice to X-rays. P. Günther and L. Holzapfel. *Zeits. f. phys. Chem. Abt.B*, **44**, 5–6, *pp.* 374–382, 1939.—When X-rays are passed through pure liquid water, H_2 is liberated. The number of H_2 molecules produced is approximately equal to the number of ion pairs which would be produced by absorption of the same amount of energy by air. Ice at — 180° is not decomposed by X-rays. A. J. M.

See also Abstract 896.

HEAT.

CALORIMETRY.

797. Specific heat of ethyl ether, nitrobenzol and carbon disulphide. J. Mazur. *Zeits. f. Physik*, **113**, 11–12, *pp.* 710–720, 1939.—A systematic investigation of the effect of temperature on the specific heat of the substances mentioned, to find whether they passed through a transformation point. No such change was observed. Nitrobenzol has a specific heat which rises uniformly with the temperature from 0·341 just above its melting point 5·70°C. to 0·350 just above 20°C. Ethyl ether has a specific heat which increases, also uniformly, from 0·476 at — 110°C. to 0·554 at

20°C., and carbon disulphide has a specific heat which increases from 0·192 at — 100°C. to 0·244 at 20°C. in a parabolic curve. G. E. A.

798. Heat capacity and thermodynamic properties of NiO. H. Seltz, B. J. De Witt and H. J. McDonald. *Am. Chem. Soc., J.*, **62,** *pp.* 88–89, *Jan.*, 1940.—Heat capacity measurements for the range 68–298°Abs., are tabulated and plotted. The entropy of NiO is found to be $8 \cdot 36 \pm 0 \cdot 1$ e.u. The free energy of formation of the oxide is calculated as $\Delta F^{\circ}_{298 \cdot 1} = -53\,034$ cal., and is expressed as a function of temperature. N. M. B.

***799. Vacuum adiabatic calorimeter.** A. B. Adams, R. S. Brown, W. H. Barnes and O. Maass. *Canad. J. of Research, Sect. B*, **17,** *pp.* 341–352, *Nov.*, 1939.—A new adiabatic calorimeter is described in which transfer of the material under investigation from the thermostat to the calorimeter is effected through an evacuated space. Authors.

***800. Radiation correction in calorimetry.** F. E. Hoare. *Phil. Mag.*, **29,** *pp.* 52–65, *Jan.*, 1940.—The radiation correction which has to be applied in calorimetry is considered theoretically, and an expression is evolved for it, in terms of constants related to the rate of cooling for unit temperature excess, and the rates of change of the temperatures considered in the absence of radiation. The result is the same as that due to Rowland except for a change in one sign. The methods of Regnault, Dickinson, and Nernst and Eucken are then considered, and values are calculated by each method from the figures for the cooling of a simple calorimeter, and show good agreement. The paper concludes with a note on the allowance for energy expenditure in the method of Nernst and Eucken, and a reference to a method due to Ferry. E. H. D.

CONDUCTION.

801. Thermal conductivity of insulating materials. E. A. Allcut and F. G. Ewens. *Canad. J. of Research, Sect. A*, **17,** *pp.* 209–215, *Nov.*, 1939.—The physical significance of " thermal conductivity " is well known, but this term has been applied commercially to a combination of conduction, convection, and radiation, which combination may vary considerably in a single material. Experimental evidence is advanced to indicate the undesirability of using this method of comparing the relative usefulness of different insulating materials. Authors.

CONVECTION.

802. Instantaneous electroconvective motion in insulating liquids. D. Avsec. *Comptes Rendus*, **209,** *pp.* 750–752, *Nov.* 20, 1939.—In continuation of earlier work [see Abstract 2162 (1937)] which had described the cellular vortex motions permanently set up in an insulating oil by a suitably applied voltage, an illustrated account is now given of the initial motion which appears for a short time when the voltage is first applied. [See following Abstract.] R. W. P.

803. Instantaneous electroconvective motion in a layer of air charged with tobacco smoke. D. Avsec. *Comptes Rendus*, **209,** *pp.* 869–871, *Dec.* 11, 1939.—The application of a suitable electric field of the order of 1 000 V/cm. is shown to give rise to a cellular vortex motion of short duration in a layer of air charged with tobacco smoke. Diagrams are given of the four characteristic stages of the phenomenon : (*i*) the formation of cusps in the upper surface of the smoke layer ; (*ii*) vertical ascent of the smoke from the centres of the crests, the smoke spreading out like an umbrella on reaching the ceiling ; (*iii*) the smoke having filled these tops

spreads downwards, until finally it becomes mixed with the air and the distinctive formation disappears. [See preceding Abstract.] R. W. P.

See also Abstracts 581, 582, 583, 584, 585, 800, 801.

DILATATION.

804. Thermal expansion of chromium-vanadium steels. P. Hidnert. *Bureau of Standards, J. of Research,* **24,** *pp.* 25–30, *Jan.*, 1940.—Data on the linear thermal expansion of several SAE Cr-V steels have been published previously. The present paper gives the results of an investigation on the linear thermal expansion of two other SAE Cr-V steels (SAE 1625 and 6150) in the annealed condition and in the quenched and tempered condition. These steels were investigated at various temperatures between 20° and 650°C. The coefficients of expansion of the hardened sample tempered at 400°F. (204°C.) or 800°F. (427°C.) are less than the coefficients of expansion of the annealed sample. Tempering at 1 200°F. (650°C.) increased the expansion to that of the annealed sample. For the range from 20° to 650°C., the average coefficients of expansion of all of the samples investigated, vary from $13{\cdot}8 \times 10^{-6}$ to $14{\cdot}8 \times 10^{-6}$ deg^{-1}C.

Author.

FUSION AND SOLIDIFICATION.

See Abstract 826.

TEMPERATURE.

805. Determination of thermodynamic scale of temperature below 1°K. by means of magnetic measurements. H. B. G. Casimir and W. J. de Haas. *K. Onnes Lab., Leiden, Comm. No.* 258*d*. *Physica,* **7,** *pp.* 70–78, *Jan.*, 1940. *In English.*—An analysis is given of the errors which may be involved in de Haas' and Wiersma's method for obtaining the thermodynamic scale of temperature below 1°K. and it is shown that an estimate of these errors may be obtained from a fairly rough determination of adiabatic M, H curves. As an example, a few measurements on iron ammonium alum are discussed. Authors.

***806. New radiation pyrometer.** J. Strong. *J.O.S.A.*, **29,** *pp.* 520–530, *Dec.*, 1939.—The pyrometer isolates from the radiation received from the object a narrow band at $8{\cdot}8\mu$ by 5 successive reflections from quartz crystals. The intensity of this band is measured with a thermopile and a galvanometer. The residual-ray system in the instrument is designed to reduce aberrations and to make use of the differences in polarization of the desired band and the undesired near infra-red to enhance the purity. The instrument can be used to determine low as well as high temperatures and is specially suited to the range 0°C. $\pm$ 100°C. Between 0°C. and 50°C. an accuracy of 0·1°C. was obtained. Various applications are discussed. W. S. S.

***807. Thermostat for room-temperature control.** J. B. Green and R. A. Loring. *Rev. Sci. Instruments,* **11,** *pp.* 41–43, *Jan.*, 1940.—A simple method for construction of an ether-vapour thermostat is described, and a relay control system for accurate temperature control of rooms is given. With this arrangement, the temperature at specified localities in a room may be kept constant to less than 0·05 deg. C. over long periods of time. Authors.

See also Abstracts 655, 703, 844.

THERMOCHEMISTRY.

808. Heats of combustion of woods and their principal constituents. G. Bertrand and G. Brooks. *Comptes Rendus*, **209**, *pp.* 733–736, *Nov.* 20, 1939.—Using a bomb calorimeter determinations have been made of the heats of combustion of 18 varieties of wood. Results are given for dried samples taken from the trunk and others from branches from which the bark had been removed. The values range from 4 060 cal./gm. for aspen to 4 927 for hornbeam, and it appears that the heats of combustion of the branch and trunk samples of the same wood do not differ appreciably. The results are discussed in relation to the heats of combustion of the constituents of the various woods. R. W. P.

809. Heats of formation and states of order in Au-Cu system. F. Weibke and U. Quadt. *Zeits. f. Elektrochem.*, **45**, *pp.* 715–727, *Sept.*, 1939.—Data are reported for the e.m.f. of various alloys against Cu as standard for a temperature range of 320°–550°C. The eutectic salt mixtures of LiCl with KCl (359°C.) and with RbCl (312°C.), with small Cu_2Cl_2 additions are used as electrolytes, and a specially designed cell to avoid disturbances due to gases, is operated *in vacuo*. A compensation circuit with mirror galvanometer as null instrument is employed. Measurements at rising temperatures are desirable, otherwise some creep occurs, especially in Au-rich alloys. The data show that above 425°C. chaotic distribution occurs, below this the presence of Au_2Cu_3 as well as AuCu and $AuCu_3$ is established. The disorder percentage at 370°C. is estimated at 4% for the first, and 0·5 — 0·4% for the other two phases. Thermodynamic deduction by use of the Gibbs-Helmholtz equation for the heats of formation of the solid solution from the solid constituents gives at 55% Cu and 500°C. a max. value of 1·25 kg.cal./gm.atom of alloy. Corresponding heats of " ordering " are 0·14, 0·38, and 0·37 k.cal. respectively for the three phases. [See following Abstract.] D. R. H.

810. Change of heats of activation of the solid solution phase AuCu on the order $\rightleftarrows$ disorder transformation. A. Schneider. *Zeits. f. Elektrochem.*, **45**, *pp.* 727–731, *Sept.*, 1939.—An alloy of composition AuCu is used as catalyst for decomposition of formic acid vapour and the change of activation energy determined for various states. On annealing the quenched solid solution between 220° and 415°C., two intermediate states occur at 250°–300° and 385°–415°. These are shown as peaks on the plot heat of activation/annealing temperature, and modulus of elasticity at room temperature/annealing temperature, and their existence is confirmed by the presence of a tetragonal lattice on X-ray powder photographs obtained with Cu$K\alpha$ radiation ; after annealing at 340° and 395°C., c/a is 0·928 and 0·986 respectively. These states show heats of activation 8–5 kg.cal. greater than the stable ordered or the chaotic state. [See preceding Abstract.] D. R. H.

811. High-temperature calorimetry of alloys. O. Kubaschewski and A. Walter. *Zeits. f. Elektrochem.*, **45**, *pp.* 732–740, *Sept.*, 1939.—Results are reported for calorimetry of powder mixtures in the Ca-Bi, Ca-Pb, Ca-Tl, Ca-Sb, Mg-Sb and Mg-Sn systems over a range of compositions, the previously described high-temperature calorimeter [see Abstract 4079 (1939).] being used. In general the compounds with high and sharp peaks on the liquidus curve in the constitution diagram, show a sharp peak on the heat of formation/composition plot. The following heats of formation in kg.cal./mole are deduced :—$CaAl_3$, 53, CaTl 35, Ca_2Pb 47,

CaPb 25, Ca_3Sb_2 160, Ca_3Bi_2 112, Mg_2Sn 17·2, Mg_2Pb 12·6, Mg_3Sb_2 68, Mg_3Bi_2 36 and 37·5. D. R. H.

812. Correlation of heats of dissociation and structure in salt hydrates and deuterates. J. Bell. *Chem. Soc., J., pp.* 72–74, *Jan.*, 1940.—Heats of dissociation of a number of salt hydrates and deuterates, calculated from dissociation-pressure measurements, show that the work required to remove D_2O molecules from a deuterate is greater than that required for the removal of the water molecules from the corresponding hydrates. This may be regarded as further evidence that the water in a normal hydrate is bound by ordinary covalent or van der Waals forces and not by special resonance linkages such as H-bonds. The effect of the H-bond in oxalic acid dihydrate is illustrated by a study of the dissociation pressures of $H_2C_2O_4$, $2H_2O$ and $D_2C_2O_4$, $2D_2O$, that of the latter being the greater. The heats of dissociation of the hydrate and deuterate are in this case almost identical, indicating a weakening of the H-bond on the introduction of D. The isotope effect is also illustrated by the greater molecular volume of $D_2C_2O_4$, $2D_2O$; in the salt hydrates a contraction of molecular volume takes place on replacement of the H_2O by D_2O. Determination of the molecular volumes of KH_2PO_4 and KD_2PO_4 again illustrates the presence of the H-bond. It is suggested that expansion of the molecular volume on the substitution of H by D may indicate the presence of H-bonds, but the converse is not necessarily true. Author.

813. Heat of formation of nitrogen iodide. F. R. Meldrum. *Roy. Soc., Proc. A*, **174**, *pp.* 425–432, *Feb.* 15, 1940.—From measurements of the heat of reaction of nitrogen iodide with excess of aqueous hydriodic acid, it is shown that the heat of formation of nitrogen iodide from the elements is − 35 kg. cal./mol. Author.

814. Combustion of aromatic and alicyclic hydrocarbons. Part III. ignition and cool-flame characteristics. J. H. Burgoyne, T. L. Tang and D. M. Newitt. *Roy. Soc., Proc. A*, **174**, *pp.* 379–393, *Feb.* 15, 1940.—The general ignition characteristics of 11 aromatic and alicyclic hydrocarbons have been investigated, and previous conclusions regarding their relative reactivity to O_2 are confirmed. While benzene, toluene, and ethylbenzene show smooth ignition curves within the limits of pressure available, the other hydrocarbons examined exhibit low-temperature ignition systems and, except in the case of *p*-xylene, cool-flames are propagated. Cyclohexane behaves as a typical paraffin, but tetrahydrobenzene, while resembling the olefines in most respects, has cool-flame limits characteristic of the aromatic series. Chemical analyses of the ultimate products of slow combustion and cool-flame reactions show that the two types of combustion yield similar results at the same temperature. The low-temperature systems of the aromatic hydrocarbons are similar to those of the paraffins, and what differences occur appear to be conditioned merely by the relative stability of analogous intermediate products. [See following Abstract.] Authors.

815. Combustion of aromatic and alicyclic hydrocarbons. Part IV. Kinetics of slow combustion of benzene and its monoalkyl derivatives at low temperatures. J. H. Burgoyne. *Roy. Soc., Proc. A*, **174**, *pp.* 394–409, *Feb.* 15, 1940.—The kinetics of the combustion of benzene and the 4 simplest monoalkyl derivatives have been studied in the temperature range between 250 and 400°C., and the results compared with those previously obtained relating to the region above 400°. It is concluded that, excepting in the case of benzene itself, the oxidation of these fuels consists

of two co-existent chain reactions, as is thought to be the case with the aliphatic hydrocarbons also. Of these processes, one is predominant below 300° and the other above 400°, whilst in the intervening range of temperature the two mechanisms proceed on terms of approximate equality. The low-temperature reaction on intensification gives rise to cool-flames, while from the high-temperature mechanism a chain-thermal ignition results. The kinetic characteristics of the two processes are demonstrated and compared. In the intermediate temperature zone (300–400°), the prominence of the process of cool-flame initiation is thought to be the partial cause of the observed increase in the " order of reaction," and it is suggested that the negative temperature coefficient is due to the mutual interaction of the co-existent chain reactions. [See preceding Abstract.] AUTHOR.

See also Abstract 611.

THERMODYNAMICS.

816. Thermodynamic surfaces of H_2O. A. L. CLARK AND L. KATZ. *Roy. Soc. Canada, Trans. Sect. III*, **33**, *pp.* 59–71, *May*, 1939.—A P-V-T surface was constructed to represent water in its vapour, liquid, and various solid modifications. Another surface, using volume entropy and internal energy as coordinates (Gibbs' Surface) was built to represent water, water-vapour, and Ice I in the region around the triple and critical points. The Gibbs' Surface is compared with others built by Kamerlingh Onnes, Boynton, Zemansky and Maxwell. The main point of difference is in the slope of the saturated vapour curve in equilibrium with the solid. In the model here described a negative specific heat of saturation is used. AUTHORS.

817. Thermodynamics of O_2-N_2 mixtures. V. FISCHER. *Ann. d. Physik*, **36**, 5, *pp.* 383–396, *Nov.*, 1939.—Investigations have been made into the equilibrium characteristics of O_2-N_2 mixtures. Comparison is made between calculations of the equilibrium concentrations by means of the method of G. N. Lewis and that of the author. Isothermal diagrams are given showing the two gas pressures and the mixture characteristics π_o and π_n are calculated from the results of Dodge and Dunbar. Tables are also given for the calculation of the isothermals and isobars of O_2-N_2 mixtures, from — 190°C. to — 148°C. and 1–20 atm. E. H. D.

818. Dissociation treatment of condensing systems. Part III. Properties of saturated vapours of H_2O, NH_3, CH_3Cl and CO_2. T. P. TSENG, S. K. FENG, C. CHENG AND W. BAND. *J. Chem. Phys.*, **8**, *pp.* 20–23, *Jan.*, 1940.—It is found that the dissociation treatment previously described [see Abstract 4625 (1939)] gives a satisfactory theory of the saturated vapour pressure curves in temperature ranges not too close to the critical point. Curves are given for PV/NkT and for surface energy in the cases of H_2O, NH_3, CH_3Cl and CO_2. In the case of H_2O there remains an appreciable discrepancy in the energy curves at low values of T/T_c. It is suggested that this may be removed by taking into account the small size of the clusters involved in the equilibrium between vapour and liquid: the surface energy in a cluster may differ from that for the liquid in bulk. A method of estimating mean cluster sizes is suggested, which leads to reasonable results. [See following Abstract.] AUTHORS.

819. Statistical mechanics of condensation phenomena in mobile monolayers. W. BAND. *J. Chem. Phys.*, **8**, *pp.* 116–120, *Jan.*, 1940.—The dissociation method [see preceding Abstract] is modified to cover the

condensation phenomena observed in mobile monolayers. The saturated tension equations are found to depend only on the number of bonds with nearest neighbours, and the mean energy per bond per molecule in the condensed phase. Assuming 6 bonds with mean energy per bond $3{\cdot}7 \times 10^{-14}$ erg per molecule, good agreement is obtained with the curves published by Adam and Jessop for the fatty acids. [See Abstract 1199 (1926).] AUTHOR.

820. Effect of ionization and dissociation on specific heats. F. MÖGLICH, K. H. RIEWE AND R. ROMPE. *Ann. d. Physik*, **35**, 8, *pp.* 735–760, *Aug.*, 1939.—Starting from Planck's partition function for a partially dissociated or ionized gas an expression is derived for the specific heat of a molecule or atom which is applicable in those regions of temperature and pressure where dissociation and ionization occur. This expression shows that the specific heat may be considered to consist of three portions : (*i*) a translational, (*ii*) an internal, (*iii*) and a pure dissociation or ionization portion. The contribution to the specific heat from (*i*) increases, whereas that from, (*ii*) decreases, as the degree of dissociation or ionization increases. The contribution from (*iii*) attains a maximum value when the degree of dissociation or ionization is 0·577. This maximum value at low pressures is more than 100 times the classical translational contribution. It decreases rapidly with increase of pressure. The final specific heat curve is therefore very greatly dependent on the pressure. As examples the authors work out the specific heats of H_2 for the dissociation $H_2 \rightarrow 2H$ and the ionization $H \rightarrow H^+$, as well as the specific heats for the first 4 ionized states of Hg. The results are shown graphically. Finally, the method is applied to semiconductors, and the specific heat curve of the electron gas of the semiconductor is shown to possess a maximum similar to that found for a dissociated or ionized gas. In one particular case considered, this maximum value is found to be about ten times the value of the specific heat of a non-degenerate electron gas. S. W.

821. Phase rule behaviour of concentrated aqueous systems of a typical colloidal electrolyte—sodium oleate. R. D. VOLD. *J. Phys. Chem.*, **43**, *pp.* 1213–1231, *Dec.*, 1939.—A partial study of the phase rule behaviour of the system sodium oleate-water has been carried out using many independent methods, including visual observation of the temperatures of phase change, dilatometric experiments, isothermal vapour pressure determinations, phase separations, and microscopic examination between crossed nicols. It has been found that a much larger number of separate phases exist than had previously been recognized in systems of soap and water, although the data are not yet sufficient to define all the phase boundaries. All the equilibria, in so far as these have been determined, and including those in which the participating phases are colloidal in nature, have been successfully represented on a phase rule diagram in which the sole independent variables are temperature and composition. The successive phases of anhydrous or nearly anhydrous sodium oleate occurring with rising temperature may represent stepwise disintegration of the crystalline lattice, each phase being less regular than its predecessor. The separate aqueous liquid crystalline or anisotropic liquid phases, which may have no anhydrous counterparts, are all smectic in type, as shown by their characteristic optical properties. AUTHOR.

822. Admixture entropies of systems of long-chain compounds and their statistical explanation. K. H. MEYER. *Zeits. f. phys. Chem. Abt.B*, **44**, 5–6, *pp.* 383–391, 1939.—It is shown that in every system as yet investi-

gated which is made by mixing a volatile (Index 1) with a chain-polymeric (Index 2) component, the admixture entropy ΔS_1 is greater than the ideal value. A statistical interpretation of this phenomenon is included with several diagrams. H. H. Ho.

823. Quasi-reversible conduction and galvanic cells with liquid-liquid junctions. F. O. Koenig. *J. Phys. Chem.*, **44,** *pp.* 101–135, *Jan.*, 1940.—Four defects of the existing thermodynamic theory of cells with liquid-liquid junctions are pointed out. In the attempt to remedy these defects, the assumptions and definitions underlying the theory are revised, account being taken of arbitrary gradients of concentrations and gravitational potential. In the course of this revision, a new manner of neglecting spontaneous diffusion is adopted, transport numbers are defined in a way more general than hitherto, and two new vectors are introduced, the specific electrolytic flow vector, $\vec{\Psi}_i$, of a component, and the specific electrolytic current vector, $\vec{J}$. It is then shown that the assumptions and definitions in question lead to a theorem, which, although implicit in previous treatments of cells with liquid-liquid junctions, is here for the first time stated explicitly and generally, and is called the condition for quasi-reversible conduction, or the qrc. condition. With the help of the qrc. condition the thermodynamic laws of cells with liquid-liquid junctions are deduced. It is found that the well-known laws for junctions with cylindrical symmetry apply unaltered to junctions which are merely chemically lamellar and simply connected, and that for the general case of junctions with any continuous distribution of chemical states and any configuration whatever, closely analogous more complicated laws hold. The general formulae for e.m.f. here obtained for the first time are verified by deducing from them the familiar laws for the case of a single electrolyte in a non-electrolyte solvent. Author.

824. Thermodynamics of solutions of substances of high molecular weight. G. V. Schulz. *Zeits. f. Elektrochem.*, **45,** *pp.* 652–658, *Sept.*, 1939.—The deviations from ideality of solutions of nitrocellulose in acetone are considered. The free energy has been determined at concentrations of 0·1–75% by observations of osmotic pressure. The deviations from ideal solutions can be explained as due to either an energy interaction between the two components, in which case there should be an evolution of heat on dilution, or the fact that the dilution entropy of a solution of thread-like molecules is greater than the mixing entropy. Determinations of the osmotic pressure at two temperatures, however, show that the two entropies are equal within the limits of experimental error. The nature of the solution is discussed. It is shown that very dilute solutions of macromolecules behave as ideal solutions, but at very high concentrations the mixture loses the properties of a solution, and approaches in behaviour a loose compound of the two components. [See Abstract 1942 (1939).]
A. J. M.

825. Thermodynamic properties of hexyl alcohols. Part III. 2-Methylpentanol-3 and 3-methylpentanol-3. F. Hovorka, H. P. Lankelma and A. E. Axelrod. *Am. Chem. Soc., J.*, **62,** *pp.* 187–189, *Jan.*, 1940.—Preparation and purification of the alcohols are described. Data for surface tension, density, viscosity and vapour pressure for the temperature range 5° to the boiling point, and for refractive index for 15° to 45° are tabulated. The average heat of vaporization and the constants for Rankine's

equation are calculated from vapour pressure data, and the parachor, Eötvös constant, total surface energy, and critical constants from surface tension data [see Abstract 2519 (1938)]. N. M. B.

See also Abstracts 604, 611, 658, 798, 920.

VAPORIZATION AND CONDENSATION.

826. Physical properties of some purified aliphatic hydrocarbons. D. B. Brooks, F. L. Howard and H. C. Crafton, Jr. *Bureau of Standards, J. of Research*, **24**, *pp.* 33–45, *Jan.*, 1940.—In an investigation of the suitability of various paraffin hydrocarbons as constituents of aviation fuel, which is being conducted for the National Advisory Committee for Aeronautics, the Navy Bureau of Aeronautics, and the Army Air Corps, 4 olefin and 7 paraffin hydrocarbons have been obtained in a high state of purity. Eight of these materials were synthesized, one was isolated from a commercial synthetic crude, and two were obtained from commercial sources. All were purified by distillation in automatically controlled fractionating columns of high efficiency. The measured physical properties of these materials included freezing point, boiling point and its variation with pressure, refractive index and density and their variations with temperature. Authors.

827. Reversible separation of binary mixtures, and the evaluation of interchanges. H. Mehlig. *Forsch. IngWes.*, **10**, *VDI-Forschungsheft No.* 398, [20 *pp.*], 1939.—The reversible fractionation of binary mixtures by distillation and rectification is discussed theoretically, and the results are discussed by reference to concrete cases of separation. J. S. G. T.

828. Activity of water in H_2SO_4 solutions at 25°C. by the isopiestic method. H. Sheffer, A. A. Janis and J. B. Ferguson. *Canad. J. of Research, Sect. B*, **17**, *pp.* 336–340, *Nov.*, 1939.—The activities of water in aqueous solutions of NaCl and of H_2SO_4 have been compared by the isopiestic method at 25°C. over a range of molalities extending up to that of the saturated salt solution. The apparatus, which was of the Sinclair type, proved to be as efficient as any yet devised. The results remove the uncertainties that previously existed in regard to the position of the m_1/m_2 curve and give a qualitative indication of the second dissociation of H_2SO_4. The calculated activities agree with the best available data. The isopiestic standard chosen by Janis and Ferguson has been confirmed over the whole molality range. [See Abstract 4106 (1939).] Authors.

829. Partial vapour pressures of water and ammonia from the system water-phospheric acid-ammonia. C. S. Huey and H. V. Tartar. *Am. Chem. Soc., J.*, **62**, *pp.* 26–32, *Jan.*, 1940.—Using the special apparatus described, the partial pressures of NH_3 and water from solutions of H_3PO_4 containing varying amounts of NH_3, were determined at 25°. These partial pressures were determined at 25° for solutions of $(NH_4)_2HPO_4$ of varying molality, and the hydrolysis constant of this salt was calculated. The dissociation pressures of NH_3 and water for the reaction: $(NH_4)_3PO_4 \cdot 3H_2O$ $(s) \rightleftarrows (NH_4)_2HPO_4(s) + 3H_2O(g) + NH_3$ (g) were measured for the temperature range 25 to 50°. Hence the following data for this reaction were computed: $\log_{10} K_p = (-9878 \cdot 4/T) + 26 \cdot 1870$, $\Delta F^\circ = 45183 - 119 \cdot 78\ T$ cal., $\Delta S = \Delta H/T$, $\Delta H = 4 \cdot 518 \times 10^4$ cal. N. M. B.

See also Abstract 652.

ACOUSTICS.

830. Scientific search for secret of Stradivarius. F. A. Saunders. *Frank. Inst., J.*, **229,** *pp.* 1–20, *Jan.*, 1940.—To test the almost universal belief that violins reached perfection in the hands of a few makers in Cremona, numbers of the best old violins and of good and bad modern instruments have been examined. Attention was concentrated on violins of the flat Stradivarius model to avoid effects due to shape, and bow speed and distance from the bridge were kept reasonably constant to eliminate the personal element. The tones tested were received by microphone, analysed and recorded, the record showing the intensity of each component in db and the frequency in c./s. Sometimes more than 30 upper partials were recorded for a given note, and the records were taken of 13 semi-tones per octave on each string with an additional octave on the high E. Using the first 4 partials in any analysis, a response curve is drawn with the musical scale as base line and the loudness as ordinate with a range of 6 octaves. It is concluded from such curves that there is no one quality which is characteristic of any violin. The response is due to the resonance usually of the top plate, the vibrations of which are compared to those of a Chladni plate complicated or modified by the presence of the sound post, the bass bar, the f-holes and the fact that the plate is fixed round its edge. The main peaks on the response curve are due to resonance in the body of the violin with the exception of the lowest peak, near the open D, which is due to resonance of the air inside the violin. Many other details are given. G. E. A.

831. Absorption of supersonic vibrations by mercury. P. Rieckmann. *Phys. Zeits.*, **40,** *pp.* 582–590, *Sept.* 15, 1939.—A comprehensive experimental investigation is described of the absorption of supersonic vibrations by Hg accompanied by full instrumental details with 10 illustrative diagrams and table of results. Possible errors and precautionary measures taken are discussed at length. Since the observed values differ from the computed data by about 26%, the author raises the question that the latter may be defective. H. H. Ho.

832. Breaking-up of macromolecules by supersonic waves. G. Schmid and O. Rommel. *Zeits. f. Elektrochem.*, **45,** *pp.* 659–661, *Sept.*, 1939.—Experiments on polystyrol in toluol are described in which different concentrations of the substance are subjected to the action of supersonic waves. The reduction in molecular weight, is, in each case, rapid at first, slowing down with continued application of the vibrations. The author concludes that it is possible to break up principal chemical valencies, e.g. the C–C bond, by purely mechanical supersonic vibrations in which the action is a simple rubbing of the molecule to pieces by the vibrating liquid. G. E. A.

833. Effects of intense sound on molten metal. Part II. G. Schmid and A. Roll. *Zeits. f. Elektrochem.*, **45,** *pp.* 769–775, *Oct.*, 1939.—The low-temperature melting alloy, Wood's metal, which solidifies and shows a needle structure when examined in section, was subjected to the action of intense sound during its solidification; sound and ultrasound waves of frequencies ranging from 50, 9000, to 284000 c./s. The intensity varied between 1 and 40 W/cm^2. It was found that the needle crystals were shortened in length to a greater extent, the more intense the sound. Th frequency had a very small if any effect. It was concluded that the grain

fining was due to the frictional forces between the molten metal and the crystals which had separated. [For Part I see Abstract 5408 (1937).]

F. J. B.

834. Supersonic effects of water vapour in CO_2 and their relation to molecular vibrations. W. H. Pielemeier, H. L. Saxton and D. Telfair. *J. Chem. Phys.*, **8**, *pp.* 106–115, *Jan.*, 1940.—Acoustic interferometer measurements at approximately 28°C. and atmospheric pressure were made from which the velocity and the absorption in CO_2 were computed. Various H_2O-concentrations were used with each frequency, covering the range 284 to 1 595 kc./s. At each frequency, μ (the absorption per wavelength) rises with increasing humidity to a maximum of about 0·28 and then drops slowly, but with the lower frequencies it also passes through a shelf or minor peak before saturation is reached. As the first absorption peak is approached the velocity drops about 10 m./sec. and a drop of 1 m./sec. occurs near the minor peak. As the frequency is increased the critical H_2O-concentration h_m is increased also but at different rates for the two peaks. For the major peak $f_m = [60 + 8(10)^4 h]$ kc./s. for the minor peak $f_m' = [50 + 2(10)^4 h']$ kc./s. Thus the average lifetime of a quantum of vibrational energy is decreased rapidly with humidity. These facts are presented as graphs. They are also correlated with results by other investigators, none of whom has observed a *minor* absorption peak and dispersion region. Most of these facts are represented quite accurately by theory, the results of which are included. Authors.

***835. Constant-path acoustic interferometer for gases at variable pressure.** C. M. Herget. *Rev. Sci. Instruments*, **11**, *pp.* 37–39, *Jan.*, 1940.—A constant-path acoustic interferometer is described, which operates by varying the pressure of the gas being studied. This variation in pressure results in the appearance of standing waves between the crystal and reflector. The resulting reaction peaks, detected by the usual methods, allow of determination of the wavelength, and consequently the velocity, if the frequency be known. Comparison is made of the results on ethylene gas at 23·0°C. and pressures between 35 to 55 atmospheres obtained with this instrument and those of a moving reflector interferometer. The two sets of data agree within the limits of error of the measurements. Author.

836. Theory of fluctuations in decay of sound. R. C. Jones. *Acoustical Soc. of America, J.*, **11**, *pp.* 324–332, *Jan.*, 1940.—A solution which is suitable for numerical computation is obtained for the classic problem of random flights in two dimensions with flights of unequal length. The solution is obtained by a development in series of the exact integral solution. The solution is applied to one aspect of the problem of the fluctuations present in the intensity of sound as it decays in a room. It is assumed that the room has reached a steady state of vibration under the excitation of a single frequency, and that the normal frequencies of the room are randomly distributed. The period of the decay is then broken into two sub-periods, in the first of which there is some degree of coherence in the phases of the normal vibrations. The treatment presented in this communication applies to the second part of the decay, comprising all but the first π/k seconds, for which the phases as well as the frequencies of the normal vibrations may be considered as distributed at random. It is found that the relative extent of the fluctuations which may be traced to beats between normal modes of vibration, does not depend appreciably on the number of characteristic vibrations excited unless the number is so

small that statistical considerations are not helpful, nor does it depend significantly on the size or shape of the room. AUTHOR.

837. Auditory significance of the term hearing loss. J. C. STEINBERG AND M. B. GARDNER. *Acoustical Soc. of America, J.*, **11**, *pp.* 270–277, *Jan.*, 1940.—For a number of years hearing impairment has been expressed by the audiogram, which is a measure of the hearing loss for sounds which are just audible to the deafened ear, with the implication that impairment for threshold sounds indicates the impairment for sounds above threshold in the range of interest to the deafened. It is shown that the audiogram is not an accurate indication of hearing impairment for above threshold sounds in cases involving nerve deafness, when the loss in loudness sensation is taken as the criterion; but when the capacity to interpret speech sounds, as indicated by articulation tests, is the criterion, the audiogram does give an approximately correct indication of the hearing impairment. The relation of the audiogram to experiences in interpreting the speech of everyday life and the relation of hearing loss to absolute ear sensitivity are given. AUTHORS.

838. Statistical measurements on conversational speech. H. K. DUNN AND S. D. WHITE. *Acoustical Soc. of America, J.*, **11**, *pp.* 278–288, *Jan.*, 1940.—Using apparatus designed to collect a large number of data in a short time, the following measurements have been made: peak and r.m.s. pressures in $\frac{1}{8}$-sec. intervals, and in various bands of frequencies up to 12 000 c./s., from the voices of 6 men and 5 women; comparison of r.m.s. pressures in $\frac{1}{8}$- and $\frac{1}{4}$-sec. intervals, from a single male voice; and distribution of the instantaneous pressures in whole speech, from a single voice. Derived from these data are peak factors in $\frac{1}{8}$-sec. intervals, and frequency distribution of speech energy in long intervals. Both the absolute value and the distribution of energy are found somewhat different from previously published results. AUTHORS.

***839. Use of thermocouple and fluxmeter for measurement of average power of irregular waves.** H. K. DUNN. *Rev. Sci. Instruments*, **10**, *pp.* 362–366, *Dec.*, 1939.—The fluxmeter has been used since 1926 for determining average pressure in a varying sound wave, but the average power has more practical significance. If the audio-frequency currents from a microphone amplifier arrangement are allowed to flow through the heater of a vacuum thermojunction, the couple of which is suitably connected to a fluxmeter, an integration of the power is obtained. Owing to the lag between thermocouple voltage and square of heater current, a double integration occurs, together with a storage of energy in both couple and fluxmeter. A careful investigation of the process and a definite routine of observation are therefore required. This investigation is carried out, and the rules necessary for a reliable measurement are set out. Limitation to the use of the couple, due to the failure at a certain temperature of Newton's law of cooling, are investigated. Suitable circuits are described. [See Abstract 855 (1940).] J. P. A.

840. Absorption of sound in O_2 and in CO_2 containing small quantities of H_2O, D_2O and Ne. Relaxation times for the vibrational energy. A. VAN ITTERBEEK AND P. MARIËNS. *Physica*, **7**, *pp.* 125–130, *Feb.*, 1940. *In English.*—Measurements were made on the absorption of sound between room temperature and about 90°C., first on pure CO_2, and then on CO_2 to which small quantities of H_2O or D_2O-vapour were added. From these measurements the relaxation times were computed. It was found that $\beta_{CO_2\text{-}D_2O}/\beta_{CO_2\text{-}H_2O}$ is equal to about 1·5 and that this ratio is nearly

independent of the temperature. Measurements were also made on CO_2 gas to which a small quantity of Ne gas was added. A small excitation of CO_2 by Ne was observed. Finally, measurements were made on the absorption of sound in oxygen gas between 50°C. and 150°C. From these data the relaxation times were computed. [See Abstract 2966 (1939).]
AUTHORS.

841. Diffraction of light by sound film of variable-width type. J. F. SCHOUTEN. *Physica*, **7**, *pp.* 101–121, *Feb.*, 1940. *In English.*—Diffraction of light by strips of sound film, as a means of immediate and exact Fourier analysis of the sound, under the headings :—Spectra obtained from various types of sound film; occurrence of all Bessel functions of integer order ; diffraction pattern and two-dimensional Fourier analysis ; relation with conventional optical gratings ; broadening of the lines due to finite length of the strip of film ; applications and possibilities. [See Abstract 1327 (1939).]
AUTHOR.

842. Possibility of acoustic image similar to that produced by light rays. Problem of vision through opaque media. R. POHLMAN. *Zeits. f. Physik*, **113**, 11–12, *pp.* 697–709, 1939.—The radiator employed was a quartz plate, with a fundamental frequency of 800 kc./s. whose third and fifth overtones were generally used. The waves were propagated through water or xylol, and were focused by means of a sound-lens or a sound-interference Fresnel zone plate. The lens was hollow, formed of thin Cu foil, and liquids found suitable for filling the lens were CCl_4 and $CHCl_3$. The lens is, for such waves, an achromat. The image is formed by making use of the directive action of the waves on a suspension of non-spherical Al particles [see Abstract 803 (1938)]. The suspension filled a flat cell with Cu foil on one side and glass on the other. The waves pass through the foil and the Al particles set themselves parallel to the wave-front. The suspension is illuminated by parallel light through the glass, and the directed particles reflect the light, forming a bright image on a dark background. An arrangement was also used to obtain images by reflected light. Finally, the waves were passed through a solid block of iron, and the images were capable of revealing a bored hole and a narrow saw cut, the latter being invisible in an X-ray photograph. The paper is well illustrated.
G. E. A.

See also Abstract
377B. Acoustic spectroscope. J. F. Schouten.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

843. Asymptotic expansions in Heaviside's operational calculus. M. FUJIWARA. *Imp. Acad. Tokyo, Proc.*, **15**, *pp.* 283–287, *Nov.*, 1939.

See also Abstracts 852, 854, 863, 864, 865, and
260B. Non-linear circuits. J. Frommer and A. Rédl.

CONDUCTION AND DISCHARGE IN GASES.

844. Luminous and total radiation intensities and black-body temperature of high-current carbon arcs. W. FINKELNBURG. *Zeits. f. Physik*, **113**, 9–10, *pp.* 562–581, 1939.—Measurements were made of the luminous

intensity of different high-current carbon arcs as dependent on the current strength, power and anode diameter. The contribution of the anode flame to the total luminous intensity was also measured. With Beck arcs the maximum intensity reached 180 000 stilbs [1 stilb = 1 Hefner candle/cm².], while ordinary high-current carbon arcs reached about 40 000 stilbs. The total radiation density was measured and found to reach a maximum value of 3 000 W/cm². for homogeneous carbon arcs and 6 000 W/cm². for Beck arcs. Calculation from the Stefan-Boltzmann law gave black-body temperatures of 4 700 and 5 800° Abs. for the crater gases of the homogeneous carbon and Beck arcs respectively. Gas and electron temperatures are considerably higher than these values. The properties of low- and high-current carbon arcs are contrasted, particularly as regards anode evaporation and anode flame radiation. All measurements confirmed the law of similarity previously stated [see Abstract 2602 (1939)], that with similar high-current carbon arcs the current strength is proportional to the anode diameter. The significance of this is discussed. Energy balance considerations for the anode-fall region explain the different slopes of the characteristics of homogeneous carbon and Beck arcs with different current strengths. A. W.

845. Transition from glow to arc discharge. E. L. E. Wheatcroft and H. Barker. *Phil. Mag.*, **29**, *pp.* 1–15, *Jan.*, 1940.—Experiments of Issendorf, Schenkel and Seeliger have indicated that, in the transition from glow to arc discharges, there occurs an intermittent breakdown similar to the relaxation of an intermittent spark. In the present work experiments are described in which this transition in air at pressures from 0·2 to 1·2 mm. Hg were recorded by means of a cathode-ray oscillograph. In order to avoid the difficulties of excessive discharge energy the tube was excited by means of a bank of condensers charged to 12 kV. A full description is given of the tube and oscillograph circuits and arrangements. The analysis of the oscillograms indicates clearly the transient breakdowns at the transition point and is interpreted as showing that the breakdowns are initiated by a sudden drop in the inter-electrode potential, corresponding to a partial discharge of the self-capacity of the electrodes. The shape of the voltage-current characteristic justifies the view that the point at which the intermittent breakdowns start is the commencement of the transition from glow to arc discharge. A series of experiments was carried out to determine the critical upper limit of voltage for the glow discharge. Several theories of the transition are examined, the most satisfactory being that of positive-ion bombardment of the cathode. J. E. R.

846. Concave cathodes. A. Lompe, R. Seeliger and E. Wolter. *Ann. d. Physik*, **36**, 1, *pp.* 9–37, *Sept.*, 1939.—Measurements are made of the focal power of a cylindrical cathode under carefully controlled conditions in Ne and the effect of variations in pressure, current strength and geometrical dimensions of the cylinder are studied for various dispositions of the anode. A concave cathode effect is observed not only at low pressures but under pressure conditions where it would not be expected from theory. An explanation is offered by suggesting that ions, diffusing from the negative glow into the region of the cathode fall, as well as metastable ions and photons impinging on the cathode surface, liberate electrons in addition to those which are known to be set free by ions produced in the cathode fall. The experimental evidence in support of this suggestion is described. H. J. H. S.

847. Excess electrons produced by u.v. light in a non-self-sustaining discharge in hydrogen. H. Costa. *Zeits. f. Physik*, **113**, 9–10, *pp.* 531–546, 1939.—Experiments are made to determine whether the electrons necessary for a self-sustaining discharge in H_2 are produced by the effect on the cathode of u.v. light emitted by the excited gas molecules. For this purpose a primary discharge, which of itself is not self-sustaining, is produced between two parallel plates maintained by u.v. light from outside falling on the cathode. A secondary similar discharge chamber is placed immediately above the first, the anodes of the primary and secondary being perforated to allow u.v. light produced in the gas of the primary to fall on the cathode of the secondary. Using the Townsend formula appropriate to this type of discharge it is found that the secondary discharge is maintained by a similar process to that of the primary, namely, by u.v. light.
W. E. D.

848. Theory of the cathode fall of a low-pressure discharge. Part III. W. Weizel, R. Rompe and M. Schön. *Zeits. f. Physik*, **113**, 11–12, *pp.* 730–739, 1939.—A system of six equations is formulated which describes the behaviour of the negative glow [see Abstract 3749 (1939)]. These equations represent a complete theory, free of contradictions. The authors take into account the processes of ionization by electron impact, of recombination, the motion of the conducting particles in the electric field and their diffusion. An equation connecting the ion density in the negative glow with the distance from the cathode is derived by an approximation method. It is shown that Scherzer's barometer formula can be used as a good approximation in certain parts of the negative glow. The conditions for its validity are discussed in detail. L. K.

***849. Starting characteristics of a " trigger " tube with a radioactive cathode.** W. B. Nottingham. *Rev. Sci. Instruments*, **11**, *pp.* 2–6, *Jan.*, 1940.—The Westinghouse WL-759 " trigger " tube is designed to operate small relays and yet is controlled by currents less than 10^{-11} A in the starting anode circuit. Investigation shows that this is possible because of an " avalanche " effect set off by the radioactivity of the cathode after the starting anode has attained the critical potential for the efficient development of the high ion density needed to bring about the complete development of a glow discharge between the cathode and the principal anode of the tube. Other electrical characteristics of the tube are also discussed. Author.

See also Abstracts 734, 770.

CONDUCTION IN SOLIDS AND LIQUIDS.

***850. Sensitivity and resolution of moving-coil galvanometers.** C. H. Cartwright. *Rev. Sci. Instruments*, **11**, *pp.* 25–30, *Jan.*, 1940.—The volt and ampere sensitivity of a moving coil galvanometer is treated in terms of the electrical circuit, the galvanometer design, and the time used for taking observation. Only cases where the current is constant are discussed; ballistic use is not treated. The term " resolution of galvanometer readings " is suggested to describe the experimentally determined change in p.d. or current that can be measured with a stated probable error in a stated measuring time under actual working conditions. The use of a galvanometer as a deflecting, partial-deflecting and null instrument is discussed. [See following Abstract.] Author.

***851. Resolving power and efficiency of moving-coil galvanometers.** C. H. Cartwright. *Rev. Sci. Instruments*, **11**, *p.* 31–36, *Jan.*, 1940.—

Formulae are derived for the change in e.m.f. and current that can be resolved with a given precision in a given time for taking readings. The resolving power of the underdamped state ($\kappa = 0{\cdot}8$) is about 10% more favourable than for critical damping. Considering a galvanometer as an engine for converting electrical energy into potential energy shows that its effective efficiency is about 40% of that of an ideal engine. [See preceding Abstract.] AUTHOR.

852. Resistance of iron wires in the frequency range 10^7 to 3×10^8 c./s. M. J. O. STRUTT AND K. S. KNOL. *Physica*, **7**, *pp.* 145–154, *Feb.*, 1940. *In German.*—The resistances of iron wires were previously measured [see Abstract 1398 (1932)] in the range 10^6–10^7 c./s., in order to test certain anomalies found by others in this region. No anomalies were found. The present measurements are an extension to about 3×10^8 c./s. Three wires have been used, of 20–40 μ thickness. The method of measurement and the results at room temperature and at the temperature of liquid oxygen (— 183°C.) are described. It is shown by Maxwell's theory, that the latter measurements may be compared with measurements at room temperature at a frequency which is 5 to 6 times the frequency used at — 183°C. No anomalies are found at room temperature, but a gradual alteration of the wire properties is found at — 183°C. with increasing frequency. Possible causes hereof are discussed. Reference is made to a future article. [See also Abstract 1810B (1939).] AUTHORS.

853. Conductivity and mobility of thin lead films. M. G. FOSTER. *Phys. Rev.*, **57**, *pp.* 42–46, *Jan.* 1, 1940.—From measurements of electric conductivity made on thin films of Pb obtained by condensing the metal on cooled glass surfaces at rates from 5×10^{12} to 100×10^{12} atoms sec.$^{-1}$ cm^{-2}. under high-vacuum conditions designed to eliminate contamination, the following results are obtained : The critical film thickness (d_c) at which the (specific) conductivity (σ) begins changing rapidly from its low value ($= 10^{-6}$ mho·cm^{-1}.) in the thinnest films to that of the bulk metal (σ_0, $= 10^6$ mho·cm^{-1}) is in the neighbourhood of 60 Å for room-temperature films, and of 30 Å for films cooled with liquid air. The mutual configuration of the condensed Pb atoms is unstable and changes with time, shown by a decrease observed in the conductivity when the film is isolated from external influences, and in the eventual appearance of a granular structure visible under the ultra-microscope. In some cases a reproducible dependence of the conductivity on the applied p.d. was observed. These effects are in harmony with the mechanism expected from considerations of the thermodynamic stability of such films, i.e. with a tendency toward aggregation resulting in the removal of mobile atoms into crystallization centres, and thus in formation of gaps which obstruct the conduction electrons. Certain deficiencies in quantitative reproducibility are ascribed to variations in the physical surface conditions on the plate where the film is condensed, presumably affecting the mobility of the layers condensed first. AUTHOR.

***854. Precision conductivity bridge assembly.** W. F. LUDER. *Am. Chem. Soc., J.*, **62**, *pp.* 89–95, *Jan.*, 1940.—An adaptation to bridge use of a new and simple low-distortion oscillator with constant voltage plate supply is described. Separate detector terminal balance is suggested and its adaptation given. The use of 10 000-Ω instead of 1 000-Ω resistors for the ratio-arms and Wagner ground circuit is proposed, and shielding to reduce stray pickup to a minimum is described. A two-stage untuned amplifier with gain sufficient to permit balancing the bridge to

1 or 2 parts per million when oscillator harmonics, a.c. hum, and stray pickup have been almost eliminated is suggested for ordinary use of the bridge, and a 3-stage tuned amplifier is described. All-round advantages with no loss in precision are attained. [See Abstract 5022 (1938).]

N. M. B.

* **855. Grassot fluxmeter as a quantity meter.** H. K. Dunn. *Rev. Sci. Instruments*, **10,** *pp.* 368–370, *Dec.*, 1939.—The approximate theory of the Grassot fluxmeter is outlined, and reason given for the rule that the fluxmeter must be at rest both at the beginning and the end of an interval of measurement, and must remain in a circuit of constant resistance. A forumla for $\int v dt$ where v is a voltage in an external circuit connected to the fluxmeter, is given, in order to show how the meter may be used with search coil or thermojunction [see Abstract 839 (1940)]. If the meter is shunted with a suitable resistance, it may be used to integrate currents, and the theory of this method is given. Finally methods of determining the instrumental constants are mentioned. J. P. A.

See also Abstracts 604, 736, 839, 863, 867, and

264B. Measurements of currents and voltages down to a wavelength of 20 cm. M. J. O. Strutt and K. S. Knol.

267B. Electrical resistance of metal contacts. J. J. Went.

DIELECTRICS AND CAPACITANCE.

856. Molecular shape and free dipole-group rotation in relation to dielectric relaxation. A. Budó. *Phys. Zeits.*, **40,** *pp.* 603–610, *Oct.* 1, 1939. —The mean moment of molecules in h.f. electric fields is calculated. The general case is then considered for molecules with an arbitrary number of dipole groups capable of free rotation about axes relative to a fixed coordinate system but which have a constant orientation. At the same time consideration of the molecular shape and the n rotating groups shows that for not too high frequencies, the mean dipole moment is determined in general by $(n + 3)$ relaxation times, the relation of which to $(n + 3)$ friction magnitudes is given. The relation previously found between the shape and effect of rotating groups is found to be a special case of the formulae derived. A. M. T.

857. Dielectric relaxation and molecular and intermolecular structure of liquids possessing dipole moments. E. Fischer. *Phys. Zeits.*, **40,** *pp.* 645–663, *Nov.* 1, 1939.—The relaxation times were measured for a number of liquid compounds in dilute solutions and in the pure liquid. It is shown that for molecules with a fixed dipole moment Perrin's theory describes satisfactorily the influence of the size and configuration of the molecule. For molecules which are electrically anisotropic and have an axis of free inner rotation, the relaxation time can be studied quantitatively as a function of the direction of the dipole moment with respect to the rotational axis. For aliphatic chain molecules (ketones, monohalogenides, alcohols) the relaxation time increases in the sequence alcohols, ketones, halogenides. Theoretical considerations show that these molecules rotate in an extended configuration in the liquid; the CH_2-OH groups shows free rotation for all concentrations. The absolute values of relaxation times measured in dilute solutions can be evaluated if a molecular viscosity is introduced which is smaller than the macroscopically measured viscosity. The results show for acetone, nitrobenzene and monochlorbenzene in the undiluted state agreement with Debye's theory of the quasicrystalline

structure of liquids. But the general theory does not explain the behaviour of alcohols with their strong interaction of the OH-groups. L. K.

858. Strong and weak dipole types. K. L. Wolf and H. Harms. *Zeits. f. phys. Chem. Abt. B*, **44**, 5–6, *pp.* 359–373, 1939.—Non-electrolytes which can form free molecular dipoles fall into two groups, one of which can be called the strong dipole type, and the other the weak dipole type, corresponding to strong and weak electrolytes. The behaviour of each class as regards variation of orientation polarization with concentration, the molecular weight, and other properties when the substance is dissolved in liquids free from ions and dipoles is discussed. A. J. M.

859. Dipole moments and structures of chlorine compounds of Ge, Cr, Se, and Te. C. P. Smyth, A. J. Grossman and S. R. Ginsburg. *Am. Chem. Soc., J.*, **62**, *pp.* 192–195, *Jan.*, 1940.—The dipole moment of GeH_3Cl was measured in the vapour state, and the moments of CrO_2Cl_2, $(C_2H_5)_2$ $SeCl_2$ and $TeCl_4$ in solution. The ratio of the moment of GeH_3Cl to that of GeH_2Cl_2 [see Abstract 229 (1940)] shows that the large size of the Ge atom largely eliminates induction between two Cl atoms attached to it. The considerable value of the moment of the molecule shows that the Ge-Cl bond moment is ~ 2 or $>$ this by the amount of the small Ge-H moment. The very small moment of CrO_2Cl_2 shows that the Cr-Cl bond is of the same magnitude as the somewhat semipolar Cr-O moment and probably, therefore, as large as 3. The large moments found for $(C_2H_5)_2SeCl_2$ and $TeCl_4$ indicate unsymmetrical tetrahedral structures for their molecules. The Se-Cl and Te-Cl bond moments necessary to produce such moments are $\gg$ those calculated as the electro-negativity differences between the elements. N. M. B.

860. Dielectric evidence of molecular rotation in crystals of certain non-aromatic compounds. A. H. White and W. S. Bishop. *Am. Chem. Soc., J.*, **62**, *pp.* 8–16, *Jan.*, 1940.—Data are tabulated and plotted giving evidence of the rotation of polar molecules in 2 derivatives of ethane, 1 of cyclopentane, 5 of cyclohexane, and 13 of camphane. In most of these solids, dielectric constant rises abruptly at a transition, as temperature is increased, to a value characteristic of polar liquids. A relatively symmetrical gravimetric and volumetric distribution of atoms around the centre of gravity of the molecule evidently facilitates its rotation in the crystal. [See following Abstract.] N. M. B.

861. Dielectric evidence of molecular rotation in crystals of certain benzene derivatives. A. H. White, B. S. Biggs and S. O. Morgan. *Am. Chem. Soc., J.*, **62**, *pp.* 16–25, *Jan.*, 1940.—Data tabulated and plotted for 13 derivatives supply two kinds of evidence of molecular rotation : (1) the dielectric constant (ϵ) of the solid behaves like that of the corresponding liquid, and (2) among these solids, ϵ may be correlated with the dipole moment of the molecule. The less symmetrical of the molecules cease rotating abruptly at transitions, and the more symmetrical show reduced frequency of rotation but no transitions as temperature decreases. Among the hexasubstituted methylchlorobenzenes, the temperature at which the relaxation time reaches a given value depends, with one exception, on the number of Cl atoms per molecule. A function recently proposed (see Abstract 807 (1939)] to describe the interaction of a molecule with its neighbours is used to explain the peculiar temperature variation of the static polarization of 1, 2, 3-trimethyl-4, 5, 6-trichlorobenzene. [See preceding Abstract.] N. M. B.

862. After-effects in solid dielectrics. B. Gross. *Phys. Rev.*, **57,** *pp.* 57–59, *Jan.* 1, 1940.—The discharge- and residual charge-curves observed in anomalous dielectrics are discussed and two general relations between them are established. Author.

863. Measurement of dielectric loss and H.F. conductivity. Part VII. H. Schwindt. **Part VIII.** P. Wulff and H. Schwindt. *Zeits. f. phys. Chem. Abt.B*, **44,** 5–6, *pp.* 344–358, 1939.—A continuation of previous work [see Abstract 529 (1940)]. In Part VII are given some theoretical considerations which arise when measurements are to be made on liquids, firstly of high permittivity, and secondly of high conductivity. In Part VIII there is described a condenser for measurements of liquids which easily absorb water. The apparatus is of silica, with Pt electrodes and gold leads, and is so designed that all filling and measuring operations can be made without exposing the liquid to the air. Some conductivities are given of mixtures, ethyl, alcohol and benzene. There is an appreciable difference in conductivity between samples that have been freed from water and those which have not. W. H. W.

864. Dispersion and absorption of electric waves in alcohols and aqueous solutions. K. E. Slevogt. *Ann. d. Physik*, **36,** 2, *pp.* 141–165, *Sept.*, 1939.—Absolute measurements from audio-frequency to about 3×10^3 Mc./s. were carried out employing the following methods: Bridge compensation at audio-frequency; a resonance method at high frequency; tuned Lecher system connected to a concentric line, the latter submerged in the liquid, for waves generated by 4-slit or 2-slit magnetron (60 cm. and 16–10 cm. respectively). Detuning and damping are shown to be negligible if the calculations are based on the ratio of the magnetic field-strengths, i.e. the ratio of the shunting bridge currents, as measured by thermocouples. The results were compared with Debye's dipole theory. The quantity λ_s, *Sprung-Wellenlänge*, was derived. (At λ_s the lateral component of the complex dielectric constant becomes maximum.) In the case of H_2O the value $\lambda_s = 2{\cdot}1$ cm. was obtained. This and the curve of dispersion-abnormal dispersion, beginning at about 10 cm., are in good agreement with the theory, which was also confirmed for alcohols; not, however, for fluids of high viscosity. H. O. S.

865. Determination of absorption by the Drude-Coolidge method. H. Slätis. *Ann. d. Physik*, **36,** 5, *pp.* 397–412, *Nov.*, 1939.—The method depends on observations of resonance in a Lecher-wire system terminated by two bridges, one of which is adjustable in position, while the other includes a thermojunction as detector. A small condenser containing the dielectric under investigation also bridges the wires at an intermediate point. The distance between the bridges corresponding to resonance before the condenser is added, and the distances between the condenser and the two bridges at resonance, after the condenser has been added, are sufficient to determine the capacitance of the condenser, and therefore, the dielectric constant. The absorption coefficient was previously deduced from the resonance curve obtained by plotting galvanometer deflection against displacement of the movable bridge. The new method depends only on the ratio of the maximum deflections observed with and without the condenser, the decrement of the arrangement without the condenser being determined once and for all by a preliminary measurement. The method is proved by observations on propyl alcohol. An experimental arrangement is described which gives concordant results by the resonance

curve and deflection methods. The procedure described provides for the use of either damped or undamped oscillations. L. H.

866. Capacity measurement with the string electrometer. J. Tagger. *Phys. Zeits.*, **40,** *p.* 695, *Nov.* 15, 1939.—In a previous paper [see Abstract 3770 (1939)] measurements of the capacitance of the Wulf electrometer with double thread were described. The present paper shows how a knowledge of the capacity of the thread system for different deflections can be utilized for certain potential measurements. A. W.

867. H.F. measurements on polar liquids and electrolytes. K. Schmale. *Ann. d. Physik*, **35,** 8, *pp.* 671–689, *Aug.*, 1939.—By comparing the l.f. and h.f. heating of samples when the l.f. conductivity was known, conductivities at wavelengths between 10 m. and 20 m. were found. Measurements were made on glycol, water, nitrobenzene, acetone, chlorobenzene, sugar dissolved in water, and a mixture with a sugar solution of cetylpyridinium chloride, a compound of notable physiological importance. In most cases the conductivities were proportional to the square of the frequency, but in the case of the mixture of cetylpyridinium chloride and sugar dissolved in water there is some evidence of a resonance at about 15 m. W. H. W.

868. E.H.F. measurements ($\lambda = 15$ cm.) of dielectric constants of polar organic liquids. R. Odenwald. *Ann. d. Physik*, **35,** 8, *pp.* 690–700, *Aug.*, 1939.—Measurements were made by Drude's second method. A pair of Lecher wires were stretched between a fixed bridge and a distant support. Near the wire at $\lambda/4$ from the bridge is a loosely coupled, aperiodic aerial with a crystal detector. Near the wire at $9\lambda/4$ from the bridge is a positive-grid oscillator. At $5\lambda/4$ is a condenser, consisting of 2 Pt wires, resting on the Lecher wire, and projecting into a glass tube containing the liquid to be measured. Resonance of the Lecher wire system was attained by moving a second bridge, at a number of wavelengths from the fixed bridge, and detected by the maximum current on the aerial. The system was calibrated by noting the setting of the movable bridge, when the condenser contained air or a number of liquids of known dielectric constant. Measurements were made of the variation of dielectric constant with temperature of nitrobenzene and a mineral oil. The results are considered to confirm Debye's theory. W. H. W.

See also Abstracts 599, 918.

ELECTROCHEMISTRY.

869. Electron-concentration cells and pH measurement. V. Karpen. *Comptes Rendus*, **209,** *pp.* 790–792, *Nov.* 27, 1939.—Referring to his former discussion of the e.m.f. of batteries [see Abstract 4384 (1939)] and the formula obtained which in many cases can be expressed in the simple form $E_{12} = RT \log (\epsilon'_2/\epsilon'_1)$, the author notes that what is measured is frequently not the ratio between the concentration in ions, H^+, of a liquid and that of a standard liquid (measure of *p*H) when the e.m.f. of a battery formed of two liquids saturated with H is measured, but in reality the ratio of the concentrations of electrons, and in many cases the ratio of the concentrations modified by the presence of H. J. J. S.

870. Electrolytic precipitation of Ag from thiosulphate solutions. R. Weiner. *Zeits. f. Elektrochem.*, **45,** *pp.* 757–759, *Oct.*, 1939.—The well-known addition of thiosulphate to Ag-depositing solutions for the purpose of increasing the brightness of the deposit was studied. Several different depositing solutions were tried, and finally a bath of the following composition was found to give satisfactory results:—40 gm./l. Ag as AgCl,

170 gm./l. $Na_2S_2O_3 \cdot 5$ aq., 20 gm./l. $NaHSO_3$, 50 gm./l. Na_2SO_4. The action of the thiosulphate in causing a bright deposit is markedly dependent on the current density. The results did not lead to the creation of a new technically useful Ag-depositing solution. F. J. B.

871. Exchange between metal and ions in solution investigated with radioactive indicators. B. V. Rollin. *Am. Chem. Soc., J.*, **62,** *pp.* 86–87, *Jan.*, 1940.—Experiments using radioactive Ag show that exchange takes place between a solution of Ag-ions and a surface of metallic Ag. In 2 hr. an exchange of Ag corresponding to 10 atomic layers was found. The exchange was increased by a factor of 10 if the surface was pretreated with $NaNO_3$ solution. N. M. B.

872. Electrolytic migration in metallic surfaces. K. E. Schwarz. *Zeits. f. Elektrochem.*, **45,** *pp.* 712–714, *Sept.*, 1939.—Po deposited on Ag showed a measurable mobility on the surface which rapidly increased with the temperature. The mobility was marked at 300°C., and the Po did not penetrate the Ag. The behaviour of the union of the atoms of Po at the surface was investigated in an electrical field. Thin Ag wires, on which Po was deposited in patches, showed a migration to the anode. An electric field of 0·1 V/cm. entirely suppressed the thermal diffusion in the direction of the cathode. F. J. B.

873. Transport numbers and diffusion potentials in salt melts. K. E. Schwarz. *Zeits. f. Elektrochem.*, **45,** *pp.* 740–743, *Sept.*, 1939.—A theoretical discussion under the heads: (1) General introduction; (2) transportation ratios; (3) stationary equilibrium between transportation and diffusion; (4) diffusion potentials; (5) relations between salt melts and liquid metals; (6) direction of wandering in transport experiments in salt melts. The author pays particular attention to the possibility of separating salt mixtures and alloys into their components, either with the molten salt or with the metals acting as electrodes. D. R. H.

874. Determination of mobilities and dissociation constants by means of conductivity titrations. J. P. Philpot, E. C. Rhodes and C. W. Davies. *Chem. Soc., J., pp.* 84–87, *Jan.*, 1940.—The possibility of determining mobilities and dissociation constants by means of conductivity titrations is discussed and illustrated. The methods given are not well suited to work of the highest accuracy, but are rapid and may prove valuable where only small quantities of material are available. It is pointed out that the general effect of a substituent amino-group is to increase, and not decrease, the acidity of a molecule, although at the same time it provides a new centre of basic properties. Authors.

875. Dissociation of Ca and Ba salts in dicarboxylic acids in water. N. E. Topp and C. W. Davies. *Chem. Soc., J., pp.* 87–93, *Jan.*, 1940.—The dissociation constants of the Ca and Ba salts of 8 dicarboxylic acids have been determined by conductivity measurements in water at 25°. A wide diversity of behaviour is shown; in 0·001 *M*-solution, for instance, barium succinate and *iso*phthalate are almost completely dissociated, whereas the weakest salt, calcium tartrate, is only 75% dissociated. The Ba salts are all stronger than the corresponding Ca salts. If the salts of the above cations are arranged in order of decreasing dissociation constant, the disposition of the anions is not the same in the two series, showing that the order is not governed solely by the diameter of the anion. The *o*-phthalates are very much weaker than the *iso*phthalates, and the maleates than the fumarates. The hydroxy-acids malic and tartaric give salts far weaker than the succinates. It is noteworthy that the ratio of the mobility of the

intermediate ion HA′ to that of the bivalent ion A″ is high for all those acids with weak Ca and Ba salts. AUTHORS.

876. Amperometric titration of nickel with dimethylglyoxime. I. M. KOLTHOFF AND A. LANGER. *Am. Chem. Soc., J.*, **62,** *pp.* 211–218, *Jan.*, 1940.—Amperometric titration curves for Ni in ammoniacal medium with an alcoholic solution of dimethylglyoxime, using the dropping Hg electrode as indicator electrode show accurate and precise results. The method is especially useful for very dilute Ni solutions, giving good results in the range 0·01 to 0·0001 molal. Interference by other metal ions is discussed. Procedures are described for the determination of Ni after removal of large amounts of Co and Fe, and give good results for Ni determination in Ni steels. [See also Abstract 534 (1940).] N. M. B.

877. Direct rapid chemical analysis with the Hg-drop electrode. J. BOEKE AND H. VAN SUCHTELEN. *Zeits. f. Elektrochem.*, **45,** *pp.* 753–756, *Oct.*, 1939.—The author describes the automatic registration of the polarization voltage of the Hg-drop electrode, as devised by Heyrovsky, with applications to the continuous control of technical processes. The electrode is made one arm of an a.c. bridge, the unbalance voltage of which is indicated, after valve amplification, on a miniature cathode-ray tube exhibiting the familar cross pattern. The action depends on the effective capacitance of the series of drops from the electrode into the solution, and hence the phase of the current and unbalance of the bridge. This capacitance is regulated by the steady potential applied and the polarization of the electrode. L. E. C. H.

878. Sb electrodes. Y. KAUKO AND L. KNAPPSBERG. *Zeits. f. Elektrochem.*, **45,** *pp.* 760–769, *Oct.*, 1939.—The effect of O_2 on the Sb electrode was shown by previous observers to be injurious to the measurement of the potential $Sb/Sb^{\cdots}$. Investigation showed that it behaved as an Sb and an O_2 electrode simultaneously. Both potentials were obtained and were reversible. The electrode O_2 reacted only slowly with the lower oxides of Sb and with the Sb itself, whereby the potential of the O_2 electrode decreased when insufficient O_2 was available. The Sb electrode was rendered passive by O_2, and this aspect is being studied. F. J. B.

879. Polarization on Ni-Fe-Co alloy electrodes during H_2 evolution in alkaline solution. G. GRUBE AND U. CROATTO. *Zeits. f. Elektrochem.*, **45,** *pp.* 815–820, *Nov.*, 1939.—This paper continues a previous investigation [see Abstract 2213 (1939)] and records measurements showing the influence of the composition of alloys on the polarization of the electrolytic H_2 evolved. Experimental details are included with 5 tables of data and 6 sets of curves for Ni-Co and Ni-Fe alloys. The polarization curves of the H_2 evolved at Ni-Fe alloys are similar to those found earlier (*loc. cit.*) for evolution of O_2. The various data are very thoroughly discussed from the standpoint of the crystalline structure of the metals and of their mixed crystals. H. H. Ho.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

880. Instability of the meson. M. A. POMERANTZ. *Phys. Rev.*, **57,** *pp.* 3–12, *Jan.* 1, 1940.—Values of the proper lifetime of the meson have been deduced from a comparison of the intensity of mesons in an inclined direction under air with that in the vertical under a superposed lead shield equivalent in absorbing power to the difference between the masses of air traversed by the mesons before reaching the apparatus in the two directions. The required mass of lead was calculated from the Bethe and Bloch

formula. The reliability of this use of the formula has been verified by an experimental determination of the relative stopping powers of water and lead. The author calculates from the experimental data that the average proper lifetime of all mesons having energies exceeding $6{\cdot}1 \times 10^8$ eV upon reaching the apparatus is equal to $3{\cdot}9 \pm 0{\cdot}3$ μsec., and the average proper lifetime of all mesons with energies exceeding $11{\cdot}9 \times 10^8$ eV upon reaching the apparatus is equal to $3{\cdot}8 \pm 0{\cdot}4$ μsec. From the same data, the proper lifetime of only those mesons having about 9×10^8 eV energy upon reaching the apparatus is equal to $2{\cdot}6 \pm 0{\cdot}8$ μsec. With the theory of Euler and Heisenberg, the proper lifetime has also been calculated from measurements of the number of disintegration electrons and their secondaries in equilibrium with the mesons in air. The value obtained by this method is roughly equal to 6 μsec. AUTHOR.

881. Specific charge on the electron. E. GOEDICKE. *Ann. d. Physik*, **36,** 1, *pp.* 47–63, *Sept.*, 1939.—The author redetermines the value of e/m by the method of Busch. Methods of electron optics are used to increase the intensity of the beam by the addition of an intermediate electrode. The detection of the beam is carried out by means of Schumann photographic plates as well as by the conventional screen. The value found for the ratio is $(1{\cdot}758\,6 \pm {\cdot}002\,3) \times 10^7$ absolute e.m.u., which, though not in accord with Wolf's value, obtained in 1927 by the same method, agrees well with modern determinations by other methods. A. HU.

882. Electron in radiation field. Part II. O. SCHERZER. *Ann. d. Physik*, **35,** 8, *pp.* 665–670, *Aug.*, 1939.—Continuing an earlier paper [see Abstract 2626 (1939)] the author applies an equation, proposed there, for the Lorentz invariance of the electron radius, to an investigation of the possibility of the splitting off of the scalar potential in the case of free electrons. As a result a method is suggested by which the equation may be applied to the case of bound electrons. G. O. B.

883. Secondary effect of mesotron radiation. B. TRUMPY. *Zeits. f. Physik*, **113,** 9–10, *pp.* 582–586, 1939.—Theoretical treatments by Bhabha and Heitler are used as a basis for discussion of new and also of old cloud-chamber measurements of the secondary effect of mesotrons. In recent measurements a Pb filter about 18 cm. thick was situated above the chamber, which was divided into 5 sections by Pb plates 0·3 cm. thick. In thin layers the mesotron radiation is accompanied by altogether 11% of secondary particles, forming a branch of the main beam. Together with the secondary particles in the neighbourhood of the main beam, the total number becomes about 17%. Measurements of the number of secondary particles set free in Fe by mesotrons showed their number to be about 11% of the mesotron radiation. A. W.

884. Angular distribution of fast neutrons scattered by atoms. Part II. T. WAKATUKI AND S. KIKUCHI. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 656–660, *Nov.*, 1939.—A previous paper [see Abstract 4145 (1939)] reported the results of experiments investigating the angular distribution of neutrons scattered by atoms in the angular region from 23° to 55°. The present paper describes the results obtained by extending the scattering angles up to 152°. Cylindrical rod scatterers of Pb, Fe and Al were used for the experiments. S. A. S.

885. Multiple scattering of electrons. S. GOUDSMIT AND J. L. SAUNDERSON. *Phys. Rev.*, **57,** *pp.* 24–29, *Jan.* 1, 1940.—A theoretical treatment of multiple Rutherford scattering is given which is exact if one considers electrons with the same total path length in the scatterer. The approxima-

tions necessary for the actual solution of the problem for a thin scatterer can be shown to have little effect on the results for small angle scattering. The distribution of scattering is expressed as a series in Legendre polynomials which has been evaluated numerically ; the final result for thin scattering is approximately a Gaussian curve. It is shown that this distribution depends in a sensitive way upon the deviation from the Rutherford law for small angle scattering due to screening by electrons. This may perhaps explain the discrepancies between experiments and theory. AUTHORS.

886. Diffraction of protons of medium energy by vapour molecules. H. J. YEARIAN. *J. Chem. Phys.*, **8**, *pp.* 24–28, *Jan.*, 1940.—The diffraction of 15–20 kV protons by CCl_4 vapour has been investigated with a l.v. arc source and electrostatic focusing with photographic registration. The principal difficulties encountered were with space-charge dispersion of the beam near the ion source, and with neutralization of the beam as it passed through the vapour. The cross-sections for neutralization and re-ionization of protons and hydrogen molecular ions in several gases and vapours were determined. The sensitivity of photographic film was found to diminish as the emulsion was outgassed but to increase 15-fold when it was treated with oil. When suitable precautions were taken to minimize the background scattering, diffraction patterns were obtained showing three maxima, the measurements of which are in satisfactory agreement with electron diffraction data. AUTHOR.

887. Problems in electron optics. J. PICHT. *Ann. d. Physik*, **36**, 3–4, *pp.* 249–264, *Oct.*, 1939.—Formulae are given for the focal length and position of the principal points of both a symmetrical and an unsymmetrical electron lens with an intermediate electrode, firstly when the deformation of the equipotential surfaces by the intermediate electrode is neglected and secondly when it is taken into account. Under certain conditions it is found that there is no deformation of these surfaces. The formulae may readily be applied to the case of an electron mirror. Certain relations previously quoted by the author for the case of an immersion lens are in error and are now corrected. H. J. H. S.

888. Ring focusing of negative ions in a cathode-ray beam. C. H. BACHMAN. *J. of Applied Physics*, **11**, *pp.* 83–85, *Jan.*, 1940.—An explanation is offered for the ring structure and some of the other configurational details associated with negative ion spots on fluorescent screens. Negative ion liberation by positive ion bombardment and the effect of the magnetic deflecting field on the positive ion paths are believed responsible for the apparent selective focusing of negative ions. [See Abstract 2130B (1938).] AUTHOR.

See also Abstracts 579, 763, 792, and 273B. Electron telescope. S. Malatesta.

ELECTROSTATICS.

See Abstracts 592, 802, 803.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

889. Examination of coloured alkali halides for photoelectric Hall effect. J. EVANS. *Phys. Rev.*, **57**, *pp.* 47–53, *Jan.* 1, 1940.—Five additively coloured alkali halides have been examined for photoelectric Hall effect by means of two different arrangements, a single cross-electrode set up and Tartakowsky's divided electrode method. The consistently null results obtained were checked by using zincblende, a substance of known photo-

electric galvanomagnetic properties, in both arrangements. From the upper limit assigned to the Hall effect, it was computed that the mean free path of photoelectrons in rock-salt is not much greater than the dimensions of a lattice cell—in agreement with v. Hippel's result for the electronic mean free path on the basis of electrical breakdown experiments. This interpretation of the null result was supported by the fact that the large initial surge of electron current in KCl and KBr at the outset of illumination also showed no Hall effect. The magnetic deflection of photoelectric current reported in rock-salt by Tartakowsky was not found, either for additively or photochemically coloured specimens. AUTHOR.

890. Electric conductivity of alkali metals in a magnetic field. E. JUSTI AND M. KOHLER. *Ann. d. Physik*, **36,** 3–4, *pp.* 349–356, *Oct.*, 1939.—The resistance of purest Na under the influence of longitudinal and transversal fields (up to 35 000 gauss) was measured at temperatures down to 14° Abs. Longitudinal and transversal effect seem to be of the same order of magnitude. Mathematical investigations are based on the assumption that the change in resistance is mainly due to the "impact-time" not being isotropic. For cubic structure the theory predicts saturation to occur under certain conditions, which are obtained in the form of $eH/mc \gg 1$. The results of theory and observations are of the same order. H. O. S.

891. Effect of reversal of magnetic field on galvanomagnetic and thermomagnetic effects. J. MEIXNER. *Ann. d. Physik*, **36,** 2, *pp.* 105–112, *Sept.*, 1939.—It is shown that, in anisotropic single crystals with non-cubic structure, the electrical resistance change in a magnetic field may alter if the field is reversed whereas in isotropic materials reversal has no such effect. The general relations between the "reversal effect" and the symmetry of the crystal structure are discussed and some experimental evidence is quoted in support of the suggestions made. H. J. H. S.

See also Abstract 919.

MAGNETISM AND ELECTROMAGNETISM.

892. Theory of paramagnetic relaxation. H. DÄNZER. *Phys. Zeits.*, **40,** *pp.* 557–558, *Sept.* 1, 1939.—According to Casimir and du Pré's theory, paramagnetic relaxation is caused in certain crystals by a difference of temperature between the system of elementary magnets and the crystal lattice which contains the paramagnetic ions. Kronig has shown that the period of relaxation is given when the probabilities of transition are stated. Both authors state that the heat transference dq from the spin system to the lattice is given by $\alpha\Delta T dt$. The writer works out a value for α which gives its connection with the probabilities of transition. A special case is thereafter examined in which an expression for the period of relaxation is found. G. E. A.

893. Arrest of magnetization by microscopic eddy currents. R. BECKER. *Ann. d. Physik*, **36,** 3–4, *pp.* 340–348, *Oct.*, 1939.—Mathematical. A general formula is worked out for the magnetic field which is set up by the microscopic eddy currents due to a given change of magnetization in the interior of a ferromagnetic body. In a particular case the result indicates the absence of ferromagnetic susceptibility at high frequencies. G. E. A.

894. Magnetic energy constants of dipolar lattices. J. A. SAUER. *Phys. Rev.*, **57,** *pp.* 142–146, *Jan.* 15, 1940.—Calculations are presented for the determination of the magnetic energy, assuming dipole-dipole interaction, of a macroscopic crystal possessing paramagnetic ions situated on a

definite lattice structure. Parallel and antiparallel configurations are considered as well as specimens of different shapes and lattice structures of various types. It is shown that the configuration of lowest energy cannot be strictly defined but is dependent upon the shape of the specimen. This configuration is an antiparallel one for a sphere but changes to a parallel one for a long slender specimen. The transition between the two configurations appears to take place at a certain critical value of the demagnetization factor. For specimens above this value the theory accounts qualitatively for the low values of the magnetization found experimentally and for the apparent constancy of the Curie point with changes of shape. Below the critical value the theory implies a pure ferromagnetic state, which is not in agreement with experiment. Probable reasons for the discrepancy are given. AUTHOR.

895. Magnetic properties of ferromagnetic impurities in non-ferrous alloys. H. SCHRÖDER. *Ann. d. Physik*, **36,** 1, *pp.* 71–96, *Sept.*, 1939.—Using the Gouy method, measurements were made of the susceptibility of Al-Zn alloys containing slight traces of Fe. It was found that in strong fields, the diamagnetic susceptibility changed slightly with time (in the paramagnetic direction), and this was shown to be due to two causes: (*a*) to the shape of the ferrous inclusions, which had a greater demagnetizing effect in some direction than others, and (*b*) to an intrinsic change with time of the magnetization of the impurities. Both these effects were studied in detail ((*b*) was very marked in β-brass), and hysteresis curves for the impurities were deduced; coercive forces of order 500 gauss were found. D. S.

896. Experiment on ferromagnetic domains. R. HAUL AND T. SCHOON. *Zeits. f. Elektrochem.*, **45,** *pp.* 663–671, *Sept.*, 1939.—Aerocolloid preparations of γ-Fe_2O_3 were made by oxidation of $Fe(CO)_5$, and the size of the crystals obtained could be controlled by variation of the reaction temperature. With reduction of this temperature the size decreased until X-ray photographs gave very broad rings usually characteristic of amorphous structure. In this region of particle size, the cubic structure of the particles could still be demonstrated by electron diffraction, and the particle size could be estimated by the broadening of the rings, in a manner similar to that described by Jones for X-rays [see Abstract 2491 (1938)]. The magnetic susceptibility of the preparations was measured by the Gouy method and showed a sudden steep increase to ferromagnetic values when the particle size exceeded 30 or 40 Å. It is concluded that this is the lower limit of the possible size of a spontaneously magnetized ferromagnetic domain; for lower sizes only paramagnetism occurs. D. S.

897. Anomalous magnetic properties of dispersion-hardened alloys. H. BUMM. *Zeits. f. Elektrochem.*, **45,** *pp.* 671–674, *Sept.*, 1939.—The author finds an anomalous increase in the initial permeability of a Fe-Ni-Cu alloy (approximately 50% Fe, 35% Ni, 15% Cu) during dispersion hardening (the hardening is produced by annealing for some hours at about 1 000°C.). The maximum permeability is obtained after about 5 hours annealing, and is shown to correspond to the early stages of separation of free Cu from the oversaturated solid solution. D. S.

898. Permanent magnet alloy with anisotropic properties. H. G. MÜLLER. *Zeits. f. Elektrochem.*, **45,** *pp.* 674–678, *Sept.*, 1939.—It is shown that cold-rolling can have a very marked effect on the magnetic characteristics of a Fe-Ni-Cu alloy (20% Fe, 20% Ni, 60% Cu) which has been heat-treated to give it good permanent magnet properties. With decrease of

thickness by 50% the remanence (B_r) in the direction of rolling increases from 3 000 to a maximum value of 5 000 gauss, while the coercive force H_c in this direction is only slightly changed from its initial value of 400 gauss. For further reduction of thickness both B_r and H_c decrease. The coercive force at right angles to the rolling direction is somewhat less than in the parallel direction. If a cold-rolled specimen (reduction of thickness by 95%) is annealed at 600°C. B_r and H_c increase to maximum values of 5 500 gauss and 500 gauss respectively, after 2 hr. and then decrease with further annealing. It is shown by various experiments that the anisotropy is due to the anisotropic stresses rather than to the crystalline anisotropy produced by the rolling. D. S.

899. Magnetic investigations of the Cr-As system. H. Haraldsen and E. Nygaard. *Zeits. f. Elektrochem.*, **45**, *pp.* 686–688, *Sept.*, 1939.—The authors measured the paramagnetic susceptibilities of alloys of the Cr-As system at various temperatures from 350°C. to −183°C. It was not found possible to prepare alloys containing more than 49 atomic % As. For about 41 atomic % As a high maximum of susceptibility is found and the alloy becomes weakly ferromagnetic at the lowest temperatures. The Curie-Weiss law is not followed for most of the alloys. D. S.

900. Magneto-chemistry of complex tetravalent Sb compounds. R. W. Asmussen. *Zeits. f. Elektrochem.*, **45**, *pp.* 698–703; *Disc.*, 703, *Sept.*, 1939.—Compounds of the type $Me^{I}_{2}[SbCl_6]$, $Me^{I}_{2}[SbBr_6]$, and $SbCl_4$ have been investigated. The electron configuration of Sb^{4+} shows that it should be paramagnetic, whilst Sb^{3+} and Sb^{5+} are diamagnetic. Actually, compounds of the above type are diamagnetic, which speaks against the existence of Sb^{4+}. X-ray structure, however, indicates the existence of Sb^{4+}. It is pointed out that Sb^{4+} could be diamagnetic if the ion were in an excited ^2P state. It is, however, considered that the properties of these compounds are best explained by giving them the doubled formula, which involves only Sb^{3+} and Sb^{5+}. A. J. M.

901. Validity of the Curie law for O_2 under pressure. M. Kanzler. *Ann. d. Physik*, **36**, 1, *pp.* 38–46, *Sept.*, 1939.—For temperatures between approximately 625 and 290 Abs. and for densities (at 20°C.) up to 0·12, the Curie law is found to hold within the limits of experimental error. For the same temperature range but for densities in excess of 0·2, the law is $\chi(T\text{-}\theta) = C$, where θ becomes increasingly negative as the density is increased. H. J. H. S.

902. Magnetic properties of salts of iron group at low temperatures. W. J. de Haas, B. H. Schultz and J. Koolhaas. *K. Onnes Lab., Leiden, Comm. No.* 259*a*. *Physica*, **7**, *pp.* 57–69, *Jan.*, 1940. *In English.*—This paper is a continuation of the work reported in a former paper [see Abstract 3034 (1939)] and contains measurements of the magnetization of $MnSO_4$, MnI_2, MnF_2, $MnBr_2$, $NiCl_2$, NiF_2, $Cr_2(SO_4)_3$, $CrCl_3$, CuF_2 and $CuSO_4$ at temperatures down to 14°K. Authors.

903. Paramagnetic relaxation in iron ammonium alum and in chromium potassium alum. F. K. du Pré. *K. Onnes Lab., Leiden, Comm. No.* 258*c*. *Physica*, **7**, *pp.* 79–92, *Jan.*, 1940. *In English.*—The observed differential susceptibility of iron ammonium alum and of chromium potassium alum proved to be in accordance with theoretical predictions. From the data found the specific heat of the spin system and the relaxation time of the spin-lattice equilibrium have been computed. [See Abstract 3809 (1939).] Author.

***904. Method for improving field uniformity in a thick solenoid.** L. W. McKeehan. *Rev. Sci. Instruments*, **10**, *pp.* 371–373, *Dec.*, 1939.—The author discusses Bühl and Coeterier's method [see Abstract 390 (1933)] of making the central field of a solenoid more uniform, by means of a single coil at the centre carrying a current in opposition to the solenoid current. In Bühl and Coeterier's paper only thin solenoids and thin correcting coils were treated, and the author gives a formula applicable also to thick solenoids for the field as a function of position in the solenoid. The best dimensions of the correcting coil were found by trial and error on the basis of this formula. D. S.

905. Magnetic screening by hollow circular cylinders. J. C. Jaeger. *Phil. Mag.*, **29**, *pp.* 18–31, *Jan.*, 1940.—The growth of magnetic field inside an infinite hollow conducting cylinder is calculated for certain aperiodic external fields. The method used is that of the Laplace transformation, displacement currents being neglected. The cases treated are those in which the external fields are (*a*) steady, (*b*) impulsive and (*c*) of the type given by $H_0e^{-\kappa t}$ and $H_0 \cos\omega t$ and are applied in a direction parallel or perpendicular to the generators of the cylinder. Two examples are worked out for the case of thick cylinders of Fe and Cu. H. J. H. S.

See also Abstracts 636, 642.

MEDICAL RADIOLOGY AND ELECTROLOGY.

906. Effect of ultra-short radio waves on plant growth. J. van Overbeek, L. R. Brantley and G. W. Potapenko. *Science*, **90**, *pp.* 470–471, *Nov.*, 1939.—Summarizes the results of an investigation of the effect of radiation on young corn seedlings with radio waves 2·5 m. long generated by a magnetron oscillator of about 25 W power. Corn seeds were germinated in moist sand in a dark room at 25°C. and 90% humidity. After 2½–3 days the seedlings were irradiated between the plates of a condenser for exposures of 20–30 sec. It was shown that the plants had a reduced growth of the first internode after radiation and had a reduced auxin production. In a number of cases additional auxin applied to the radiated plants by means of a paste of indolacetic acid applied to the tips of the seedlings made the internode grow normally again. Effects similar to that of irradiation could be produced if the young seedlings in a control experiment were kept in an electric oven at 48°C. for 30 min. It follows that at least under the conditions of these experiments the effect of ultra-short waves on young corn seedlings can be accounted for as a heat effect. T. A. C.

907. Bio-electric potentials of the hen's egg. A. L. Romanoff and C. L. Cottrell. *Science*, **90**, *pp.* 471–472, *Nov.*, 1939.—A pair of physiological saline solution capillary electrodes was applied to the open egg, with one electrode touching the albumin several mm. beyond the yolk while the other electrode successively was placed on the top of the yolk in contact with points at various distances from the centre of the blastoderm. An electron-tube microvoltmeter was used to measure the p.d. existing between the electrodes. A duotriode 6C8G tube was used with a pair of parallel filament resistances forming the grid biases close to floating grid p.d. to minimize battery fluctuations. The input grid was brought accurately to floating grid p.d. by an additional potentiometer control and the input was then applied across 10 MΩ between grid and earth. The electrodes proper were of Ag-AgCl and were constant to several μV during a run and the sensitivity of the voltmeter and electrodes was slightly above 10^5 mm./V with a wall galvanometer. Graphs are given showing the

p.d. in mV plotted against the distance from the centre of the blastoderm in mm. up to the margin of the yolk both for fresh eggs and those after 8, 12, 16 and 24 hr. incubation. There was evident an increase in p.d. with incubation up to 7·5 mV which was several times greater than through the shell. On the same egg the p.d. decreased as the contact was moved away from the blastoderm though some differences were still indicated at the margin of the yolk. Fertile eggs showed on the average about 0·8 mV p.d. while with infertile eggs the difference averaged less than 0·2 mV. T. A. C.

908. The indirect radiograph. A. Bouwers. *Radiology*, **33**, *pp.* 357–362, *Sept.*, 1939.—The indirect radiograph, obtained by means of a reduced picture of the screen image with a lens, is compared with the direct exposure. The result is that, with approximately equal contrasts, the unsharpness of the indirect method is approximately $\sqrt[3]{I/I'}$ times greater than in the case of the direct exposure, when I/I' is the ratio of the light intensity, I, in the large image to I′, that in the reduced image. This ratio can easily be calculated from the aperture d/f of the lens, viz.: $I/I' = 16\,(f/d)^2$. The lens must, therefore, have as large a relative aperture as possible without the reproduction faults exceeding the indicated limits. The photographic quality of the indirect image is approximately equal to that of the direct image (ordinary technic) when for the indirect image a tube with a rotating anode is used and for the direct image a tube with a stationary anode. The most suitable size is approximately that of the miniature camera, 24 × 32 mm²., when a lens is used with an effective circle of confusion not larger than about 30 μ. The conditions are indicated under which with a lens having a relative aperture of $f/1·5$ and the application of the rotating anode, approximately the most favourable exposure is obtained. Author.

***909. Apparatus for stereoscopic roentgenography of the skull.** P. C. Hodges. *Am. J. of Roentgenology and Radium Therapy*, **42**, *pp.* 921–929, *Dec.*, 1939.—For multiple examinations of the skull in standard positions for various medical and surgical investigations an apparatus is described and illustrated in great detail. Briefly, a special stand to orientate the head in any desired position for investigation is supported on a tube stand, in conjunction with a metal earth protected X-ray tube. B. J. L.

***910. Topographical radiographic mensuration and its surgical applications.** G. Contremoulins. *Bull. de Photogrammétrie*, **9**, *pp.* 1–27, *Jan.–Feb.–March, and pp.* 51–71, *April–May–June*, 1939.—In Part I of this paper a description is given of a radiographic apparatus for the localization of foreign bodies within a patient to an accuracy of some tenths of 1 mm. The principle is essentially a development of that given in an earlier paper of the author [see Abstract 3269 (1904)], but with all the improvements now made possible by the use of powerful X-ray tubes, shorter exposures and anti-diffusion screens. Radiographs are taken in two positions with a lateral shift of the X-ray tube, using a three point compass in contact with the skin of the patient. After the removal of the patient this compass position can be reproduced accurately on the " table métroradiographie " and wires are then stretched from the exact point in space of the two positions of the focal spot of the X-ray tube to the shadows on the radiographs. The position of the foreign body is shown by the intersection of the thin wires and its position in respect to points marked on the skin can be determined with great accuracy. In Part II of the paper this system is applied to the mensuration of the skeleton, to the determination of pelvic

diameters which are required in obstetrics to an accuracy of 4 mm. and also to the mensuration of the long bones for the purpose of synthesis of fractures of the neck of the femur. Attachments to the table are described for the abduction and angle of rotation for the shaft in the neck of the femur and reduction of the fraction, insertion of pins and for endoprosthetics. The development of the apparatus over a period of 40 years at the Hospital Saint-Germain-en-Laye is described in great detail for which the original papers should be consulted. T. A. C.

***911. Body-section radiography.** S. MOORE. *Radiology*, **33**, *pp.* 605–614, *Nov.*, 1939.—The author has applied the name of "laminagraph" to the apparatus of Kieffer [see Abstract 2635 (1938)] and "body-section radiography" as a more preferable general term to that of "stratigraphy" by Vallebona or "planigraphy" by des Plantes or "tomography" by Grossmann and Chaoul. In the laminagraph there is a circular movement of the tube and film of amplitude 7°. The spiral movement differs from that of the des Plantes apparatus which is Archimedean. The present apparatus has an inverse logarithmic spiral which should ensure a more uniform dispersion of the shadows. The minimum thickness of the layer which can be laminagraphed is of the order of from 2–5 mm. but the thickness of layer can be increased by decreasing the excursion of the tube and film carriage according to the pathological condition of the anatomical region under investigation. There is a complete discussion of the type of case suitable and of the technique; film and intensifying screens are standard, target-film distance is dictated by the grid ratio and a line focus tube is used. Laminagraphs have been made in as short a time as 1 sec. with the spiral motion and it is predicted that with sufficient transformer power, body-section radiography will be no more difficult than other standard radiographic procedures. T. A. C.

912. Theory of the biological action of X-rays. J. A. REBOUL. *Comptes Rendus*, **209**, *pp.* 792–794, *Nov.* 27, 1939.—In continuation of previous papers [see Abstract 1839 (1939)] the author derives a new form of the theory of X-ray action on biological materials assuming that (*a*) the law of action of X-rays on a biological population is a law of probability and (*b*) the probability of lethal effect on a cell (or the probability for a given effect to be attained) is at each instant a function of the dose of X-rays already applied. It is pointed out that the vulnerability of cells varies during their life cycle, some cells may be injured by 2 quantum "hits" others may require 45 or more. Examination of the experimental survival curves shows that the probability α can either be constant (exponential survival curve) or not. Curves derived from the experimental results show that the function increases, passes through a maximum then decreases before becoming constant, similar to a curve of resonance. It is important to ensure that a given dose of X-rays corresponds to the maximum of probability for the lethal effect of a group of cells. On this basis it is possible to determine the optimum conditions in the case of treatment of biological material composed of identical individuals for a constant dose of X-rays applied within a given time. T. A. C.

913. Effect of heavy filtration on skin tolerance and depth dose. R. DRESSER AND A. MELTZER. *Am. J. of Roentgenology and Radium Therapy*, **42**, *pp.* 756–759, *Nov.*, 1939.—There is diversity of view as to the best filtration to give maximum depth dose, with minimum skin dose, for X-rays excited at 200 kV. This is of economic importance in respect to the time factor and, therefore, the number of patients which can be

treated with any particular apparatus. The authors have, therefore, investigated the subject, with various types of apparatus operated at 200 kV, and comparative data have been obtained at 400 and 1 000 kV. It is found that increasing the filtration from 0·5 mm. to 2 mm. copper, the skin tolerance is so little altered as not to warrant the prolongation of the treatment time. The authors also consider the increase of skin tolerance by increase of exciting voltage, whilst definite, is open to question as to the relative value of these high voltages, in comparison to 200 kV. Biological effectiveness of heavy filtration is not discussed but the results obtained for many years at 200 kV cannot be discounted. Radiation therapy cannot be administered on physical factors alone, as biological effects and physical measurements do not necessarily run in parallel.

B. J. L.

914. Method of obtaining greater ratio of deep to surface dosage. S. J. Hawley. *Am. J. of Roentgenology and Radium Therapy*, **42**, *pp.* 760–763; *Disc.*, 763–765, *Nov.*, 1939.—On physical grounds, rotation of a patient receiving X-ray treatment is suggested as a method of increasing the depth dosage, with more even distribution (and therefore less undesired effects) upon the superficial tissues. Measurements have been made by use of a phantom of wood having the form of the human pelvis. Measurements show that the depth dose can be considerably increased, with reduction of the skin dosage, as required, the intensity distributions being measured at right-angles. In the discussion comment is made as to this particular method having been suggested at least as long ago as 1916. Whilst the method may be applicable to radiation of a limb, use of a limited number of X-ray beams may be more advantageous for the body from the aspect of the patient. Growths in the body do not occur exactly at the centre, as is theoretically necessary for the full application of the proposed method.

B. J. L.

See also Abstract

305B. The St. Bartholomew's Hospital X-ray tube for one million volts. T. E. Allibone, F. E. Bancroft and G. S. Innes.

OSCILLATIONS AND WAVES.

***915. Apparatus for accurate measurements of audiofrequencies.** R. B. Ewell, W. E. Roseveare and K. Schaaf. *Rev. Sci. Instruments*, **11**, *pp.* 39–40, *Jan.*, 1940.—An apparatus and procedure is described for measuring electrical frequencies from 1 to 15 kc./s. with an accuracy of 0·001%. The broadcast frequency of a radio station is subdivided to give 100·000 cycles. Beats between the unknown frequency and known integral multiples of the 100 cycles are then counted. Authors.

916. Relation between actual and virtual ionospheric height. H. G. Booker and S. L. Seaton. *Phys. Rev.*, **57**, *pp.* 87–94, *Jan.* 15, 1940.—Translation of virtual height of the ionosphere into actual height is achieved by fitting a parabolic maximum of electron density to observations of variation of virtual height with wave frequency. Methods for measuring the thickness of a region and the height of maximum electron density are described and applied. The simplest measure of the actual height of maximum electron density is the virtual height at $\frac{5}{6}$ of the penetration frequency. This measure is found to be remarkably reliable for F-region at night. During the daytime it is often necessary to correct F_1 observations for presence of E-region, and F_2 observations for presence of F_1-region. A simple technique of correction is described and applied. The

disadvantages of minimum virtual height for quantitative study of diurnal variation of ionospheric height are emphasized. AUTHORS.

See also Abstracts 719, 864, and

341B. Propagation of wireless waves round the earth. B. van der Pol and H. Bremmer.

PHOTO-ELECTRICITY.

917. Photo-e.m.f. in photo-elements of the metal-semiconductor-metal type. Part V. G. MÖNCH. *Ann. d. Physik*, **36**, 1, *pp.* 1–8, *Sept.*, 1939.—Continuing previous work [see Abstract 916 (1936)] the potentials generated by illuminating a polycrystalline Cu-Cu_2O-Cu element suspended in liquid air have been measured. Details are given of the preparation of the elements and of the particular optical arrangements used, which gave potentials of about 5×10^{-2} V. By half immersing the element in liquid air it was shown that there was no rectifying action at the boundary between metal and semiconductor. With one side of the element illuminated the conductivity varies according to the direction of the current. The diffusion formula gives a much lower value of the potential than that measured. J. B. W.

See also Abstracts 596, 847, 889.

PIEZO-ELECTRICITY.

918. Elastic, dielectric and piezo-electric constants of heavy-water Rochelle salt. A. N. HOLDEN AND W. P. MASON. *Phys. Rev.*, **57**, *pp.* 54–56, *Jan.* 1, 1940.—Crystallization of Rochelle salt from D_2O raises the upper Curie point of the material by 11°C. and lowers the lower point by 5°C., but leaves the other properties substantially unchanged. AUTHORS.

THERMO-ELECTRICITY.

919. Theory of thermo-electric effects in a magnetic field. J. MEIXNER. *Ann. d. Physik*, **35**, 8, *pp.* 701–734, *Aug.*, 1939.—It is first pointed out that although the first of Thomson's relations between the thermo-electric effects follows rigorously from the first law of thermodynamics, the second relation cannot be deduced rigorously on thermodynamic grounds alone since the effects are always associated with irreversible production of Joule heat and irreversible flow of heat due to thermal conductivity. The second relation can be rigorously deduced from the electron theory of metals, but the proof requires that the resistance tensor should be symmetrical, and since this symmetry is destroyed by a magnetic field (due to the Hall effect), the second relation need no longer hold in a magnetic field. The author then gives a detailed electronic theory of the effects in a magnetic field which confirms this, and shows that the Thomson and Peltier effects are no longer reversible. From the theory the temperature and field dependence of the thermo-electric, transverse galvanomagnetic and thermomagnetic effects is deduced for $T > \Theta$ in fair agreement with available experimental data. D. S.

920. Transformation energies. B. BRUŽS. *Zeits. f. Elektrochem.*, **45**, *pp.* 703–706, *Sept.*, 1939.—The conception of transformation energy is developed from consideration of reciprocal pairs of systems (e.g. a thermo-element and a thermally insulated bi-metallic wire carrying a current). A. J. M.